

Flora Survey of Green Spring Unit, Colonial National Historical Park

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ABSTRACT

This study of the Green Spring National Historic Park, a 195 acre tract of land owned by the National Park Service and located in Virginia's Coastal Plain five miles west of Williamsburg, was conducted to analyze the floristic and vegetational composition of the site. This study also served to document the exotic species at Green Spring, to compare Green Spring's vegetational composition to other forests in the Coastal Plain, and to quantify woody species diversity. A total of 241 species from 185 genera and 80 families were identified at Green Spring, 20% of which were non-native. No rare, threatened, or endangered species were found at Green Spring, though four records for James City County were discovered. Analysis of the vegetational data with detrended correspondence analysis separated the forested areas at Green Spring into four communities: successional pine forest, pine/mixed hardwood forest, lowland mixed hardwood forest, and upland mixed hardwood forest. Detrended correspondence analysis of the Green Spring forests with other Coastal Plain stands showed that Green Spring's forests do not differ substantially in vegetational composition compared to other Coastal Plain stands. The Shannon index of diversity was used to quantify the species diversity of woody vegetation at Green Spring and to compare it to other sites in Virginia's Coastal Plain. Green Spring's successional pine and sweetgum-rich hardwood forests were less diverse than similar stands, but the pine/mixed hardwood forest was intermediate in species diversity.

INTRODUCTION

The Green Spring National Historic Park is a 195 acre tract of land that is part of the Colonial National Historic Park. Green Spring is located in the Coastal Plain of Virginia in the James River watershed approximately 3 ½ miles north of Jamestown in James City County. Green Spring is a subset of the historic site of Governor William Berkeley's mansion and 1,090 acre plantation during the latter half of the seventeenth century and has a long history of disturbance. Governor Berkeley's agricultural activities were extensive, and the area has been subject to other destructive activities since the plantation's abandonment. Although several archaeological investigations have been conducted at Green Spring, no study has investigated the floristic and vegetational composition of the remaining 195 acres. This research examines the flora and vegetation of Green Spring with two major objectives:

- (1) To document and identify the vascular plants of Green Spring, and
- (2) To determine the vegetational structure of the forests surrounding the Green Spring ruins.

Data collected from this research will be used to address additional questions. These are: (1) How many species of rare, threatened, or endangered plants occur at Green Spring?; (2) Which non-native species occur at Green Spring and can any of these be identified as having potential historical significance pertaining to importation or experimentation by Governor Berkeley and later landowners?; (3) How does the Green Spring site compare with similar communities in overall species diversity and forest composition?

History of Green Spring

William Berkeley, an English gentleman born in 1608, was appointed Governor of Virginia in 1641. In 1643 he acquired a tract of land containing 1,090 acres known as Green Spring where he built a house sometime before 1649. Between 1660 and 1677, he established a typical 17th century plantation where he raised rice, flax, silk, and tobacco, produced wine and timber products, and experimented in horticulture (Caywood 1955). During Berkeley's 17 year tenure as governor of Virginia, Green Spring was occasionally used as a meeting place for the General Assembly and even as a camp for Nathaniel Bacon's rebel forces. After Berkeley's death in 1677, the estate passed on to his wife Frances. She soon married Colonel Philip Ludwell, whose family used the estate for 125 years. In 1781 troops of Lord Cornwallis and the Marquis de Lafayette fought the Battle of Green Spring Farm, leaving the house in ruins. William Ludwell Lee employed an architect in 1796 to make plans for improvements and repairs, but the plans were never carried out and the manor house was abandoned (Hume 1996).

In 1929 Jesse Dimmick, the owner of the Green Spring property and an amateur archaeologist, conducted an excavation of the ruins and drew a plan of the foundation (Fig. 1). In 1955 the state funded an excavation to be directed by the National Park Service as part of the celebration of Virginia's 350th anniversary in 1957. Louis R. Caywood directed the excavation, most of which involved reexcavating that which Dimmick had already examined. Weather conditions were poor, with periods of daily freeze/thaw cycles, leading to extensive damage to the mortar and bricks. When the 350th Anniversary Commission was unable to find a sponsor to support a reconstruction

[illegible]

of the manor house, the workers simply reburied the foundations to preserve the remnants of the structures (Hume 1996).

Currently the National Park Service (NPS) is engaged in conducting a Phase I archaeological survey at Green Spring. Phase I surveys consist primarily of shovel tests at 50 foot intervals, which involve screening the soil for artifacts and then refilling the hole. Any artifacts found will be kept by the NPS, and the discoveries from this preliminary study will direct future archaeological efforts at Green Spring. As of March 30, 1998, the archaeologists had covered 85 acres of Green Spring and had performed 1,400 shovel tests (Jane Sundberg, NPS, personal communication).

Physical Description

Green Spring National Historic Park lies 5 miles west of Williamsburg at the intersection of Rte. 614 and Rte. 5 (Fig. 2). The site contains a central field which holds the majority of the ruins from Governor Berkeley's home. On the west side of Rte. 614 (Fig. 3, A), the field is mown annually by the National Park Service while the eastern portion of the field (Fig. 3, B) was undergoing successional processes at the time of this survey. It was mown in the Spring of 1998 to facilitate the efforts of the NPS archaeologists (June Sundberg, NPS, personal communication), so the species composition of this area has been altered. This unmown field contained large quantities of *Rubus* spp., *Prunus serotina*, and *Liquidambar styraciflua* in addition to a variety of grasses and forbs, including *Lespedeza cuneata*, a problematic invasive species. Its soil is primarily a Slagle fine sandy loam, which is deep, nearly level, and moderately well drained. This field also contains a section of Newflat silt loam, which is deep, nearly level and somewhat poorly drained (USDA 1981). The mown field hosts a variety of grasses, sedges, and rushes in addition to several species of forbs, many of which are members of the Asteraceae. There are three major soil types in this field, most of which is a Slagle fine sandy loam. The soils at the site of the archaeological investigation are loamy Udorthents, which is deep, well drained, loamy soil in areas where the soil has been disturbed by excavation or grading. Another significant soil type in this field is the Betheria silt loam, which is deep, nearly level, and poorly drained (USDA 1981).

North of the mown field is an area of successional pine forest (Fig. 3, C), which is largely dominated by young *Pinus taeda* individuals. In late winter and spring, much of

**Green Spring Environs
Colonial National
Historical Park**



Created: 3/21/99, NPS/COLLO



Green Spring Unit Colonial National Historical Park



- Green Spring Unit
- Parcels
- Roads
- Buildings
- Topography, 5 ft
- Wetlands
- Palustrine
- Fields
- Forest



Created 3/21/98, NPS-COLO



unmown field (B), successional pine forest (C), lowland pine/mixed hardwood forest (D), and upland mixed hardwood forest (E) are indicated on the map. this area was submerged by several centimeters of water, but this dried up by late June. The summer of 1997 was unusually dry, however, so this area may typically be submerged for a much longer period of time. This submerged area is actually higher in elevation than its surroundings (Fig. 3), but the soil found here, a Slagle fine sandy loam, is poorly drained (USDA 1981) and is probably responsible for the water retention. Other common woody species in this area include *Liquidambar styraciflua*, *Liriodendron tulipifera*, and *Acer rubrum*. Much of the forest floor is bare, but large populations of *Lycopodium* spp. and several members of the genus *Carex* are common.

South of both the mown and unmown fields on either side of Rte. 614 is a flat, extremely moist lowland area through which a small stream flows eastward (Fig. 3, D). The forest is primarily composed of a mixture of pine and hardwood species and is in a more advanced stage of succession than the area north of the mown field. The loblolly pines are larger than those in the successional pine forest and have an average diameter at breast height (DBH) of 37 cm. In addition, an assortment of hardwoods are invading the understory and becoming more important in the canopy. The understory commonly consists of dense patches of *Lindera benzoin* and a variety of other shrubs. The forest floor is covered with forbs and grasses, most notably dense mats of *Senecio aureus* which form in early spring. The soil here is mostly Chickahominy silt loam, which is deep, nearly level, and poorly drained, though there is also a portion of the area composed of Newflat silt loam. There are also patches of Peawick silt loam, a deep, nearly level,

moderately well drained soil and Craven-Uchee complex, a moderately well drained complex of Craven soils and well drained Uchee soils on steep slopes (USDA 1981).

West of the mown field is a sloping area (9 m rise per 50 m horizontal distance) covered primarily by mixed hardwood forest (Fig. 3, E). The forest is composed mostly of *Liquidambar styraciflua*, *Quercus* spp., *Fagus grandifolia*, and *Liriodendron tulipifera*. The understory consists primarily of *Cornus florida*, *Carpinus caroliniana*, and Ericaceous shrubs. It also houses several orchid species and a variety of other forbs. Soils common here are the Craven-Uchee complex and Slagle fine sandy loam. There is also a section of Emporia complex, which consists of areas of deep, moderately steep, well drained Emporia soils and areas of similar soils formed over layers of fossil shells (USDA 1981).

METHODS

Forty collection trips were made between February 19, 1997 and December 12, 1997 to gather specimens. Each type of vegetation (i.e., mown field, unmown field, successional pine forest, pine/mixed hardwood forest, lowland hardwood forest, and upland hardwood forest) was sampled at least every two weeks during the growing season in order to collect the plants at the optimal stage of the life cycle for identification purposes. To facilitate collection efforts, six transects were set up parallel to Rte. 614 at 100 yard intervals and were marked with pink flagging. These transects were used as reference points for random surveys of each vegetational zone to ensure that a variety of areas were sampled. Voucher specimens were collected for each species except *Cypripedium acaule*, which had only one individual at Green Spring, and *Quercus coccinea* and *Phoradendron serotinum* which did not have any collectable material within reach. For these species, photographs or slides were used for documentation. Upon returning to the laboratory, easily keyed specimens were identified with Bailey (1949), Gleason and Cronquist (1991), Harlow (1959), Radford, et al. (1968), or Roane (1991) prior to pressing, but difficult species were dried and determined at a later time. Nomenclature followed Gleason and Cronquist (1991). Voucher specimens will be deposited in the College of William and Mary Herbarium (WILLI).

In order to determine the percent of the Green Spring flora composed of non-native plants, Gleason and Cronquist (1991) and Harvill, et al. (1992) were consulted to determine the known geographic region of each species. The proportion of exotics at

Green Spring was then compared with the results of other floras in Virginia. To determine if any of Green Spring's species are listed threatened or endangered, Terwilliger (1991) was consulted. Data regarding the status of the rare species were obtained from the Virginia Natural Heritage Program's World Wide Web site (Ludwig 1998). This page lists species ranked S1, S2, or S3 and those species listed endangered or threatened at the federal or state level. S1 is a designation for species that are extremely rare or have less than five populations or individuals in the state and are particularly vulnerable to extirpation. S2 species are very rare with 5-20 populations in the state and are susceptible to extirpation. S3 species are defined as rare to uncommon and have 20-100 populations in the state; these may be vulnerable to long-term disturbances (NHP 1998). Information regarding species of historic horticultural interest was obtained from Julie Bell of the National Park Service (personal communication).

In addition to the floristic study, a vegetational analysis was conducted in order to determine the diversity and the forest composition of Green Spring. Twenty-five circular plots were sampled along the transects at intervals of approximately 90 meters (Fig. 4). Because of the rough terrain and dense vegetation, these intervals were paced off with the distances estimated from stride length. Due to the narrow width of the portion of the site east of Rte. 614, the six plots in this area (T, U, V, W, X, and Y) were placed halfway between the transect and the road or border on each side of the transect instead of on the transect to increase the number of sample points. To facilitate comparison with other vegetational analyses of comparable sites, I followed a modified version of the sampling methods used by Cazier (1992), Mort (1994), Plunkett (1990), and Weldy (1995). This

Fig. 4. Approximate location of vegetational analysis sample plots at Green Spring.



involved determining the cross-sectional area at breast height of each tree or shrub (i.e., woody species) within a circular plot with a radius of 10 meters. These woody species were put into two size classes: the small class includes woody species with a diameter of 2.5-10 cm, and the large size class includes any woody species with a diameter greater than 10 cm. The relative density was calculated for each species in each size class by dividing the number of stems for that species in each size class by the total number of stems in the class. The relative dominance for each species was calculated for the large size class by dividing the cross sectional area for all stems of a single species by the total cross-sectional area of all stems in the large size class. An importance value was then calculated for each species in the large size class by averaging its relative dominance and the relative density in the large size class.

The importance values for each plot were analyzed with CANOCO (ter Braak 1988), a computer program with an option for detrended correspondence analysis (DCA), to cluster the plots according to the species composition. Ordination techniques like DCA are useful in interpreting community data because they organize the data based exclusively on species abundance and summarize the data by producing easily understood, low-dimension plots where similar samples are grouped together. DCA is generally considered to be superior to other ordination techniques such as principal components analysis (PCA) or reciprocal averaging (RA) when analyzing vegetational data because DCA eliminates the common problems of the arch effect and axis compression (Pielou 1984). The arch effect occurs in methods like RA because a strong

systematic relationship exists between the first and second axis. The two axes are not allowed to be correlated, but the arch in the data allows one leg of the arch to be positively correlated with the second axis while the other leg is negatively correlated. The correlations effectively cancel each other out, leaving a misleading relationship between axes. DCA corrects for this by permitting no relationship between the two axes by detrending. Detrending is the process of dividing the first axis into a number of segments within which axis 2 scores are adjusted to an average of zero by subtracting the segment mean from each site score. This eliminates the arch and causes the samples to be grouped solely by the weighted averages of species scores (Gauch 1982).

Another serious problem with many ordination techniques is the compression of the data points located at either end of the axes, which causes some data points to appear to be more related than they actually are. DCA solves for this by rescaling each axis so that distances on an axis are easy to interpret and are consistent with the degree of difference between samples (Peet 1988).

Each of the 25 sample plots at Green Spring had a list of species that were assigned importance values (see Appendix A). The importance values for the 26 species found in the large size class in these plots became the variables for DCA. The results from this analysis were used as an aid to group the Green Spring plots into communities, which were named successional pine forest, pine-mixed hardwood forest, lowland mixed hardwood forest, and upland mixed hardwood forest.

The next analysis was designed to compare the forest composition at Green Spring to that in other forest stands on Virginia's Coastal Plain. The vegetational data

from Green Spring's individual plots were combined into four broad categories of forest vegetation (successional pine forest, pine/mixed hardwood forest, lowland mixed hardwood forest, and upland mixed hardwood forest) to generate importance values for the each of the four community types. This value was determined by averaging importance value across all plots within the vegetation type for each species. The successional pine forest values were determined by combining plots A, H, and I; the pine/mixed hardwood data came from plots B, E, J, N, P, R, T, U, V, W, and X; the lowland mixed hardwood forests from plots C, D, F, G, K, and Y; and the upland mixed hardwood forest data came from plots L, M, O, Q, and S. These average importance values were then compared to importance values determined by other vegetational analyses in the area by using DCA. The data were extracted from studies in several sites in the hardwood forests of the Coastal Plain of Virginia (Cazier 1992), the Tar Bay and Powell Creek watersheds (Mort 1994), western Isle of Wight County (Plunkett 1990), and the Corrotoman River Watershed (Weldy 1995). A total of 39 stands and 50 species were analyzed by DCA

To assess the diversity of woody species at the Green Spring National Historic Park and to compare it to other floristic analyses on the Coastal Plain of Virginia with larger sampling areas, the Shannon index of diversity (H') was employed. This statistic assumes that individuals are sampled randomly from an effectively infinite population and that the sample is representative of the species in the area of inference. Its equation is:

$$H' = -\sum p_i \ln p_i$$

where the quantity p_i is defined as the proportion of individuals found in the i th species (Magurran 1988). This statistic was calculated for woody vegetation only because vegetation sampling for the herbaceous flora was not carried out.

The values for the Shannon index of diversity at Green Spring, the Corrotoman River watershed (Weldy 1995), Western Isle of Wight County (Plunkett 1990), and the Tar Bay and Powell Creek watersheds (Mort 1994) were calculated from vegetational analysis data. For Green Spring, original data from this study were used, but the other H' values were calculated from the vegetational data collected and presented in the previous studies. These studies were chosen because they reported the data necessary to compute H' , they encompassed a wide range of land areas, and they are located in the Coastal Plain of Virginia. The value p_i was calculated by determining the number of stems of each species in both size classes. This number was then divided by the total number of stems of all species to determine the proportion of individuals in the i th species and used in the equation to calculate the Shannon index of diversity. To facilitate understanding of the potential effect of area on species diversity, the total number of species found in each floristic analysis was plotted against the sample area of each study.

RESULTS

The Green Spring National Historic Park was found to contain 241 species from 185 genera and 80 families (see Annotated Checklist). Of these, 4 were James City County records and include the following species: *Botrychium biternatum*, *Carex normalis*, *Carex virescens*, and *Carya ovata*. None of the species at Green Spring were listed as rare, threatened, or endangered and no species were found that are designated as S1, S2, or S3 (extremely rare, very rare, or rare to uncommon) by the Virginia Natural Heritage Program. Of the species found at Green Spring, 20% are non-native. Several of the exotics at Green Spring have been targeted by the Natural Heritage Program in Virginia as problematic species and include *Lespedeza cuneata*, *Cirsium vulgare*, *Lonicera japonica*, *Rosa multiflora*, *Ligustrum sinense*, *Ailanthus altissima*, *Microstegium vimineum*, and *Glechoma hederacea* (NHP 1997).

Green Spring has had a long history of agricultural activities, beginning with William Berkeley in 1645, and continuing through Philip Ludwell II (1672-1727), Philip Ludwell III (1716-1767), William Lee (1770s-1795), William Ludwell Lee (1790s-1803), and William Hodgson (1800s-1804) (Table 1; Bell, NPS, personal communication). Several of the species cultivated by these men are present at Green Spring and include *Asparagus officinalis* (asparagus), *Juglans nigra* (black walnut) *Morus alba* (white mulberry), *Phleum pratense* (timothy), and *Pyrus communis* (pear). *Pinus* spp. (pines) and *Quercus* spp. (oaks) are also listed as economically important species at some point in Green Spring's history, but since many species in these genera are native to the area, it is impossible to say that any pines or oaks found at Green Spring today are there through

Table 1. A partial list of cultivated plant species at Green Spring, 1645-1850 (Julie Bell, NPS, personal communication). Latin species names were found in Gleason and Cronquist (1991). Some common names were too vague to apply species names.

William Berkeley Era (1645-1677)

Tobacco (*Nicotiana tabacum*)
 Rice (*Oryza sativa*)
 Apricot (*Prunus armeniaca*)
 Peach (*Prunus persica*)
 Quince (*Chaenomeles speciosa*)
 *Pear (*Pyrus communis*)
 Mellicoton (Peach grafted onto Quince)
 Flax (*Linum* spp.)
 Hemp (*Cannabis sativa*)
 *Mulberry (*Morus* spp.)
 *Black Walnut (*Juglans nigra*)
 Grape (*Vitis* spp.)
 Corn (*Zea mays*)
 Indigo (*Baptisia* spp.)

Philip Ludwell II Era (1672-1727)

Pear varieties:
 P.H. Russett
 White Russett
 Pierce's Russett
 Maryland Russett
 Orange (*Citrus* spp.)
 Golden Wilding Apple (*Pyrus malus*)
 Corn (*Zea mays*)
 Tobacco (*Nicotiana tabacum*)
 Wheat (*Triticum aestivum*)
 Indigo (*Baptisia* spp.)
 Flax (*Linum* spp.)

William Lee Era (1770s-1795)

Tobacco (*Nicotiana tabacum*)
 *Timothy (*Phleum pratense*)
 *White Mulberry (*Morus alba*)
 Apple (*Pyrus malus*)
 Broccoli (*Brassica rapa*)
 Cauliflower (*Brassica rapa*)
 Peas
 Windset Beans
 Dutch Artichoke
 Red Clover (*Trifolium pratense*)
 Corn (*Zea mays*)

William Ludwell Lee (1790-1803)

Corn (*Zea mays*)
 Tobacco (*Nicotiana tabacum*)

William Hodgson (early 1800s-1804)

Cypress (*Taxodium* spp.)
 *Pine (*Pinus* spp.)
 *Oak (*Quercus* spp.)

1850 agricultural census

Hay
 Corn (*Zea mays*)
 Oats (*Oryza sativa*)
 Irish Potato (*Solanum tuberosum*)
 Sweet Potato (*Ipomoea batatas*)
 Peas
 Beans
 Wheat (*Triticum aestivum*)

*Species found at Green Spring in 1997

historical introductions. Two species of daffodils (*Narcissus pseudonarcissus* and *N.*

biflorus) were found in the mown field surrounding the ruins at Green Spring and are cultivars that were popular in England when the British colonized this area.

Consequently, they are suspected to be descendants of plants brought to the New World by the colonists (Brent Heath, Gloucester Daffodil Mart, personal communication).

Vegetational analysis at Green Spring yielded values of relative dominance, relative density of two size classes, and importance values for 25 sample plots (see Appendix A). Detrended correspondence analysis (DCA) was then applied to the data from these plots to separate the individual plots into forest communities (Fig. 5). Visual examination of the sample plots and of the importance values for each plot aided in grouping the data points on the DCA ordination into four communities characteristic of Virginia's central Coastal Plain: successional pine forest, pine/mixed hardwood forest, lowland mixed hardwood forest, and upland mixed hardwood forest. Plots A, H, and I were included in the successional pine forest; plots B, E, J, N, P, R, T, U, V, W, and X were in the pine/mixed hardwood forest; plots C, D, F, G, K, and Y were in the lowland mixed hardwood forest; and plots L, M, O, Q, and S were grouped in the upland mixed hardwood forest. In this ordination, the eigenvalue of the first axis was 0.57 and the second axis' value was 0.37. Total inertia was 3.183. Only the first four eigenvalues were reported, so these values are the relative, rather than the absolute, measures of the variance described by the eigenvector, or axis (Whittaker 1987). The cumulative percentage variance for the first axis is 18.0% and the second axis' value is 29.7%.

After the data from Green Spring's individual plots were grouped into four forest communities (successional pine forest, pine/mixed hardwood forest, lowland mixed

hardwood forest, and upland mixed hardwood forest) these communities were analyzed with forest stands from other studies on the Coastal Plain of Virginia by DCA. This ordination (Fig. 6) had eigenvalues of 0.47 for the first axis and 0.30 for the second axis with a total inertia of 3.55. The cumulative percentage variance for the first axis was 13.1% and the second axis' value was 21.6%.

The contour lines on the DCA plots (Figs. 5 & 6) indicate where species have a high importance value (I.V. > 15) in the individual sample plots or stands. In the Green Spring plot, the pine-mixed hardwood forests are separated from the mixed hardwood forests by the degree of importance of *Pinus taeda*. Also, the upland forest plots tend to have high importance values for *Q. alba* while *Acer rubrum* and *Fraxinus pennsylvanica* tend to be concentrated in bottomland forests. In the plots comparing Green Spring stands to those from other vegetational analyses, *Pinus taeda* again separates the pine-mixed hardwood forests from the more mature mixed hardwood forests. The bottomland forests with large quantities of *Liquidambar styraciflua* and *Acer rubrum* clustered in the upper right hand corner of the ordination, while the beech-rich upland forests clustered in the middle left portion of the plot. The Green Spring stands each came out well within the cluster of stands in the forest type to which they belonged (Fig. 6, stands 36-39).

The major species in the successional pine forest is *Pinus taeda* (Table 2). The importance value (I.V.) is a measure of canopy dominance that takes into account the amount of biomass in a species and the number of individuals of a species. *Pinus taeda* is by far the most important canopy species in this forest with I.V. = 84.34. Table 3

Fig. 5. A detrended correspondence analysis (DCA) ordination of sample plots at Green

Spring. Dashed lines show where the indicated species have an importance value greater than 15 in the plot. Four communities are indicated: successional pine forest (Δ), pine/mixed hardwood forest (\square), lowland mixed hardwood forest (\circ), and upland mixed hardwood forest (\blacklozenge).

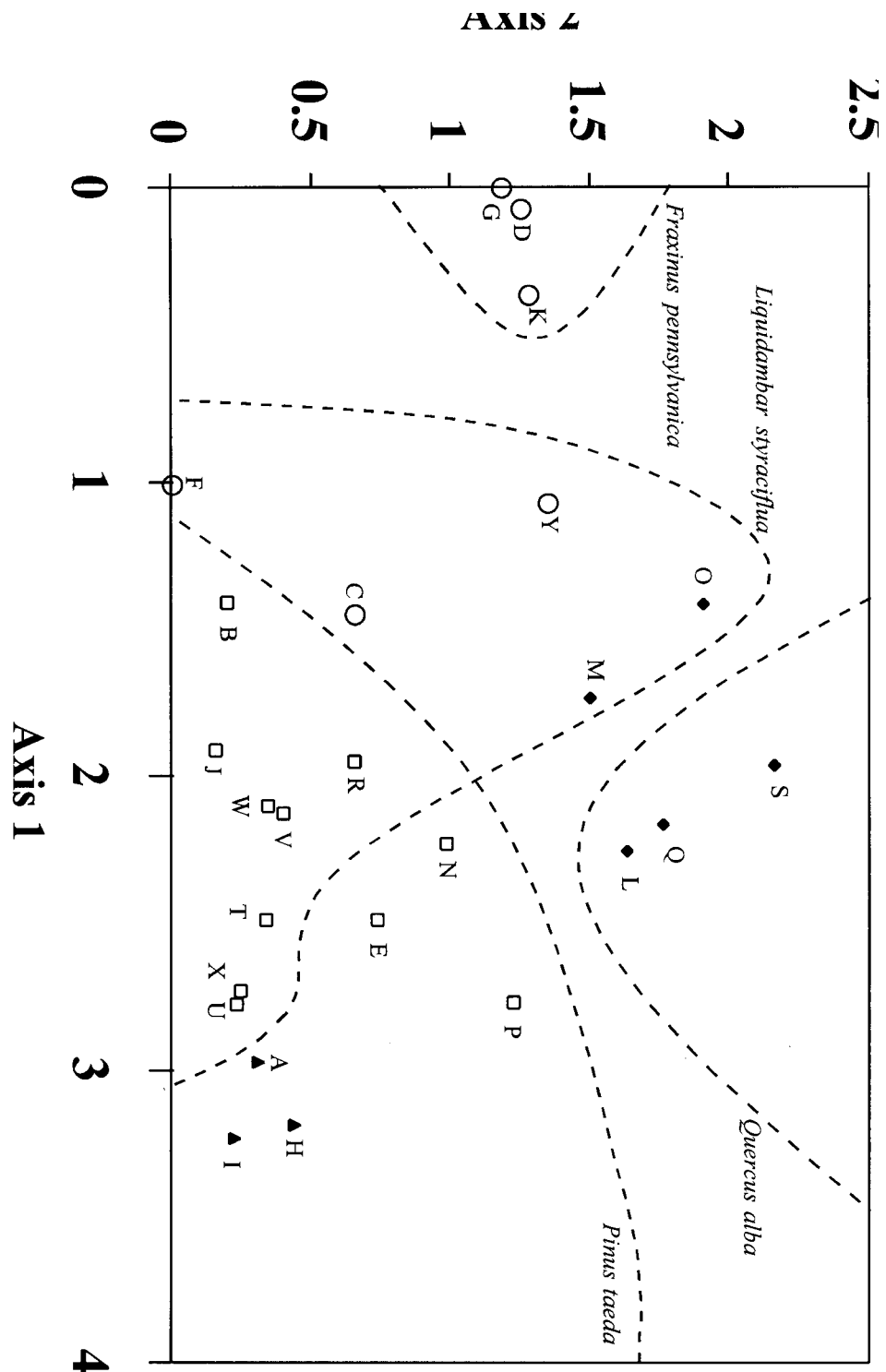
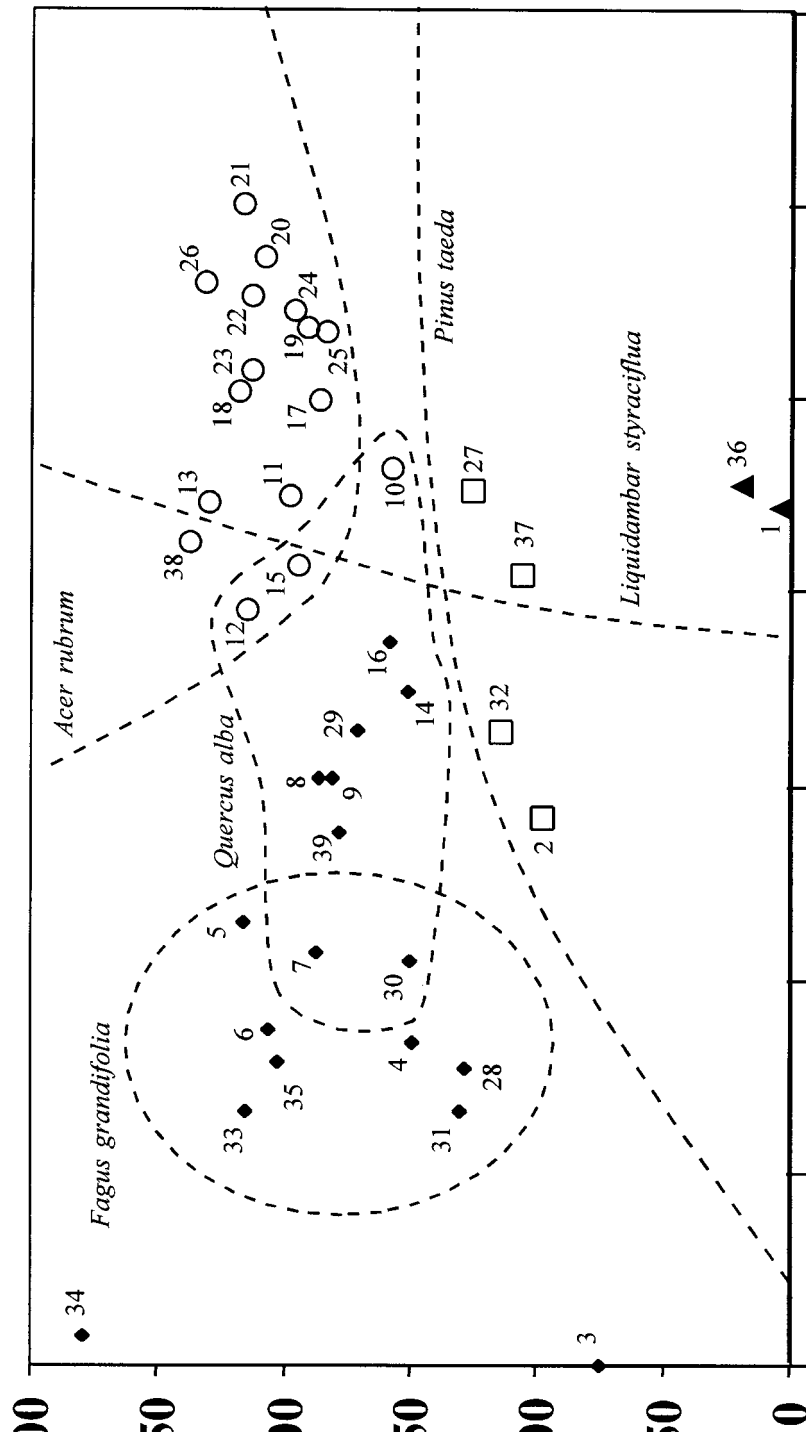


Fig. 6. A DCA ordination of forest stands at Green Spring and those analyzed by Cazier (1992), Mort (1994), Plunkett (1990), and Weldy (1995). Stands 36-39 are from Green Spring, 5-26 from Cazier, 32-35 from Mort, 27-31 from Plunkett, and 1-4 from Weldy. Dashed lines show where the indicated species have an importance value greater than 15 in the stand. The four communities shown are successional pine forest (Δ), pine/mixed hardwood forest (\square), lowland mixed hardwood forest (\circ), and upland mixed hardwood



forest (◆).

Table 2. Vegetational data for a successional pine forest at Green Spring. Relative Dominance is a measure of the relative cross-sectional area at breast height for each species in the large size class. Relative Density is the proportion of stems in a size class belonging to each species. Importance Value (I.V.) is the average of Relative Dominance and Relative Density of the large size class.

<u>Species</u>	Relative <u>Dominance</u>	Relative Density		<u>I.V.</u>
		<u>Small</u>	<u>Large</u>	
<i>Pinus taeda</i>	87.73	2.70	80.95	84.34
<i>Liquidambar styraciflua</i>	4.95	70.27	8.57	6.76
<i>Liriodendron tulipifera</i>	2.79	3.60	5.71	4.25
<i>Myrica cerifera</i>	2.10	2.70	2.86	2.48
<i>Pinus virginiana</i>	3.52	1.80	1.90	2.17
<i>Acer rubrum</i>	----	5.41	----	----
<i>Ilex opaca</i>	----	4.50	----	----
<i>Juniperus virginiana</i>	----	3.60	----	----
<i>Diospyros virginiana</i>	----	1.80	----	----
<i>Cornus florida</i>	----	0.90	----	----
<i>Fagus grandifolia</i>	----	0.90	----	----
<i>Sassafras albidum</i>	----	0.90	----	----

Table 3. Vegetational data for a pine/mixed hardwood forest stand at Green Spring. Relative Dominance is a measure of the relative cross-sectional area at breast height for each species in the large size class. Relative Density is the proportion of stems in a size class belonging to each species. Importance value (I.V.) is the average of the Relative Dominance and the Relative Density of the large size class.

Species	Relative Dominance	Relative Density		I.V.
		Small	Large	
<i>Pinus taeda</i>	45.70	3.78	29.96	37.83
<i>Liquidambar styraciflua</i>	15.38	21.31	36.56	25.97
<i>Liriodendron tulipifera</i>	15.47	5.15	8.37	11.92
<i>Acer rubrum</i>	4.03	15.12	7.05	5.54
<i>Quercus falcata</i>	6.18	----	1.32	3.09
<i>Quercus phellos</i>	3.56	0.34	1.32	2.44
<i>Cornus florida</i>	1.12	10.31	3.52	2.32
<i>Carya tomentosa</i>	3.58	3.09	0.88	2.23
<i>Quercus alba</i>	2.52	2.75	1.32	1.92
<i>Nyssa sylvatica</i>	1.72	1.03	0.88	1.30
<i>Ulmus americana</i>	0.66	1.03	1.76	1.21
<i>Diospyros virginiana</i>	0.70	1.03	1.32	1.01
<i>Quercus rubra</i>	0.62	2.41	1.32	0.97
<i>Platanus occidentalis</i>	0.20	----	0.88	0.54
<i>Ilex opaca</i>	0.26	21.65	0.44	0.35
<i>Fagus grandifolia</i>	0.24	4.12	0.44	0.34
<i>Juglans nigra</i>	0.20	----	0.44	0.32
<i>Fraxinus pennsylvanica</i>	0.18	----	0.44	0.31
<i>Quercus velutina</i>	0.04	0.34	0.44	0.24
<i>Quercus michauxii</i>	0.02	0.34	0.44	0.23
<i>Vaccinium corymbosum</i>	----	0.34	----	----

Table 3 (cont.)

<i>Carpinus caroliniana</i>	----	5.15	----	----
<i>Quercus coccinea</i>	----	0.34	----	----
<i>Sassafras albidum</i>	----	0.34	----	----

shows that *Pinus taeda* is also the most important species in Green Spring's pine/mixed hardwood forest (I.V. = 37.83), but *Liquidambar styraciflua* (I.V. = 25.97) and *Liriodendron tulipifera* (I.V. = 11.92) are also important constituents of the canopy. In Table 4, it can be seen that *Liquidambar styraciflua* is the most important species in the lowland mixed hardwood forest (I.V. = 27.61), with *Acer rubrum* (I.V. = 25.57) and *Fraxinus pennsylvanica* (I.V. = 15.57) also making significant contributions to the canopy layer. *Liquidambar styraciflua* is also dominant in the upland hardwood forest (I.V. = 20.02; Table 5), but *Quercus alba* (I.V. = 12.71) and *Fagus grandifolia* (I.V. = 11.02) are also important canopy species.

Green Spring's woody species diversity was assessed by comparing the values obtained for the Shannon index of diversity (H') to those of other floristic studies of various sites in the Coastal Plain of Virginia (Mort 1994, Plunkett 1990, Weldy 1995; Table 6). Green Spring's successional pine and sweetgum-rich hardwood forest had lower values of species diversity with $H' = 1.44$ for successional pine and $H' = 2.09$ and $H' = 2.29$ in the sweetgum-rich forest, while Mort's successional pine forest had $H' = 2.03$, and in Plunkett's sweetgum-rich forest $H' = 2.38$. The number of woody species in each of these stands included in the calculation of Shannon's diversity index were 12, 17, 19, 11, and 17, respectively. Green Spring's pine/mixed hardwood stand exhibited an intermediate level of species diversity with $H' = 2.32$ and 25 species included in the calculation compared to other stands in Virginia's Coastal Plain which had $H' = 2.45$ (Mort 1994), $H' = 2.29$ (Plunkett 1990), and $H' = 2.20$ (Weldy 1995). These stands had 21, 21, and 18 woody species, respectively. Mort's beech-rich hardwood stands had

Table 4. Vegetational data for a lowland mixed hardwood forest at Green Spring. Relative Dominance is a measure of the relative cross-sectional area at breast height for each species in the large size class. Relative Density is the proportion of stems in a size class belonging to each species. Importance Value (I.V.) is the average of the Relative Dominance and the Relative Density of the large size class.

Species	Relative Dominance	Relative Density		I.V.
		Small	Large	
<i>Liquidambar styraciflua</i>	31.31	8.33	23.91	27.61
<i>Acer rubrum</i>	19.62	25.00	31.52	25.57
<i>Fraxinus pennsylvanica</i>	12.66	----	18.48	15.57
<i>Ulmus americana</i>	6.76	19.44	8.70	7.73
<i>Quercus falcata</i>	7.97	----	1.09	4.53
<i>Ilex opaca</i>	8.33	27.78	1.09	4.71
<i>Carya ovata</i>	7.57	----	1.09	4.33
<i>Pinus taeda</i>	4.81	----	2.17	3.49
<i>Liriodendron tulipifera</i>	2.68	1.39	3.26	2.97
<i>Nyssa sylvatica</i>	0.65	1.39	2.17	1.41
<i>Juglans nigra</i>	1.45	----	1.09	1.27
<i>Quercus velutina</i>	0.43	----	1.09	0.76
<i>Morus alba</i>	0.09	----	1.09	0.59
<i>Cornus florida</i>	----	9.72	----	----
<i>Fagus grandifolia</i>	----	4.17	----	----
<i>Diospyros virginiana</i>	----	1.39	----	----
<i>Quercus michauxii</i>	----	1.39	----	----

Table 5. Vegetational data from an upland mixed hardwood forest at Green Spring. Relative Dominance is a measure of the relative cross-sectional area at breast height for

each species in the large size class. Relative Density is the proportion of stems in a size class belonging to each species. Importance Value (I.V.) is the average of the Relative Dominance and the Relative Density of the large size class.

Species	Relative Dominance	Relative Density		I.V.
		Small	Large	
<i>Liquidambar styraciflua</i>	21.05	14.88	18.99	20.02
<i>Quercus alba</i>	16.56	----	8.86	12.71
<i>Fagus grandifolia</i>	6.85	17.36	15.19	11.02
<i>Quercus falcata</i>	13.28	----	3.80	8.54
<i>Quercus phellos</i>	11.52	----	3.80	7.66
<i>Ilex opaca</i>	2.76	38.84	8.16	5.46
<i>Carya tomentosa</i>	5.78	----	5.06	5.42
<i>Acer rubrum</i>	4.45	1.65	6.33	5.39
<i>Pinus taeda</i>	5.90	3.31	3.80	4.85
<i>Quercus rubra</i>	5.52	----	3.80	4.66
<i>Liriodendron tulipifera</i>	3.94	0.83	5.06	4.50
<i>Carpinus caroliniana</i>	1.22	8.26	3.80	2.51
<i>Nyssa sylvatica</i>	1.47	1.65	2.53	2.00
<i>Carya glabra</i>	1.25	0.83	2.53	1.89
<i>Cornus florida</i>	1.01	9.92	2.53	1.77
<i>Quercus velutina</i>	0.67	----	2.53	1.60
<i>Fraxinus pennsylvanica</i>	----	0.83	----	----
<i>Juniperus virginiana</i>	----	0.83	----	----
<i>Sassafras albidum</i>	----	0.83	----	----

Table 6. Woody species diversity in five community types. Data from Ingram (this study), Mort (1994), Plunkett (1990), and Weldy (1995). The species diversity measure reported is the Shannon index of diversity (H'). The number of woody species included

in the calculation is indicated by *N*. Multiple entries in a cell means that the study included more than one stand with that designation and required multiple calculations of *H'*.

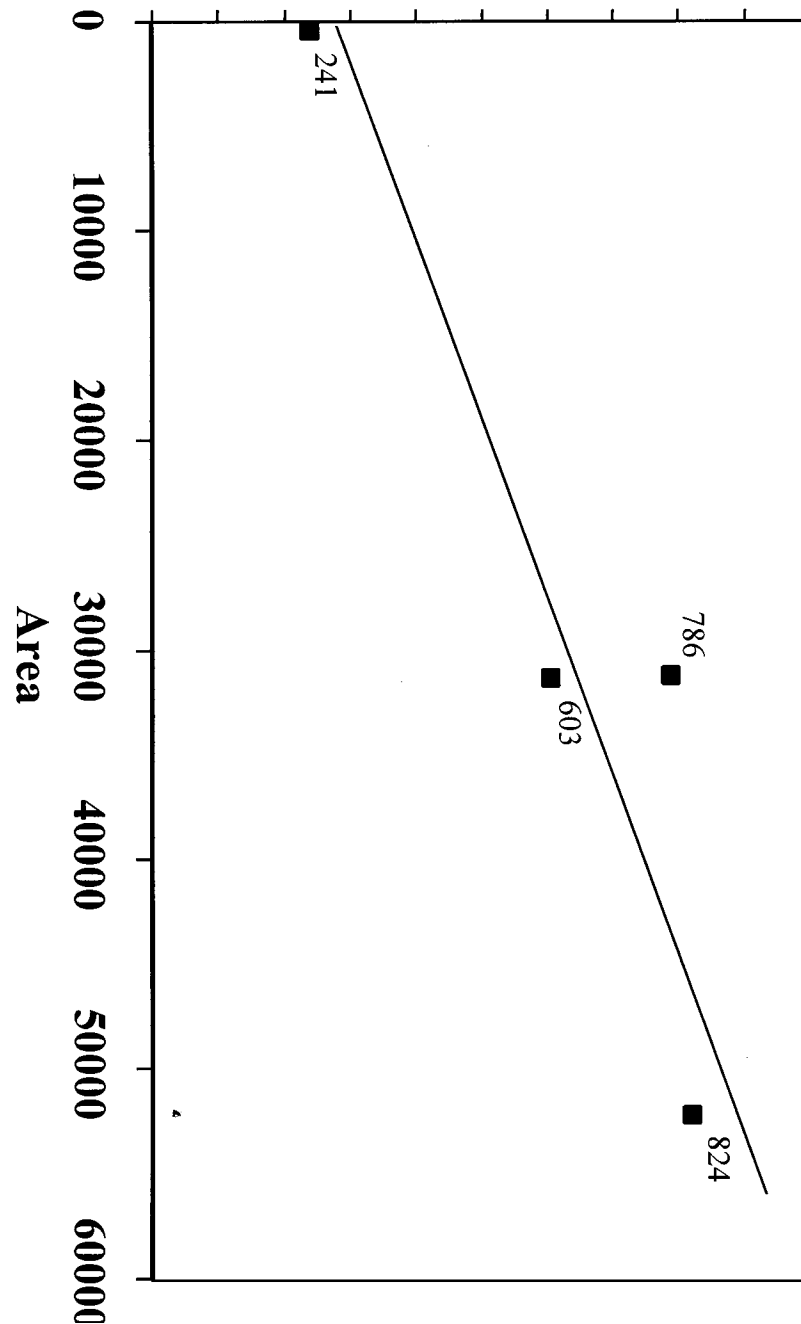
	Ingram		Mort		Plunkett		Weldy	
	<i>H'</i>	<i>N</i>	<i>H'</i>	<i>N</i>	<i>H'</i>	<i>N</i>	<i>H'</i>	<i>N</i>
Successional Pine	1.44	12	2.03	11	---	--	----	--
Pine/Mixed Hardwood	2.32	21	2.45	21	2.29	21	2.20	18
Sweetgum-Rich Hardwood	2.29 2.09	19 17	----	--	2.38	17	----	--
Beech-rich Hardwood	----	--	1.70 1.99	11 15	2.10 2.36 2.50	13 17 17	2.26	16
Hickory-rich Hardwood	----	--	1.34	13	----	--	2.21	14

lower *H'* values (1.70 and 1.99) than those of Plunkett (2.10, 2.36, and 2.50) or Weldy (2.26). Mort's stands had 11 and 15 woody species while Plunkett had 13, 17, and 17 woody species and Weldy's stand had 16 woody species. Mort's hickory-rich hardwood stand also had a low value ($H' = 1.34$) compared to Weldy's $H' = 2.21$. Mort's stand included 13 woody species, and Weldy's had 14. The values for Shannon's index of diversity and the number of woody species in each stand that were involved in the calculation of *H'* are included in Table 6.

Green Spring also differed from these other floristic studies with respect to area, number of species, and the number of rare species. Green Spring's area of 195 acres is

much smaller than the 32,000 acres investigated by Mort (1994) and Plunkett (1990) or the 51,200 acres studied by Weldy (1995). The total number of species at Green Spring was also much smaller with 241 species while the Tar Bay and Powell Creek watersheds had 786 species (Mort 1994), Western Isle of Wight County had 603 species (Plunkett 1990), and the Corrotoman River watershed housed 824 species (Weldy 1995; Fig. 7). A regression on the species/area plot showed that the number of species actually found in these studies were close to the predicted values ($r^2 = 0.88$; $p = 0.059$). Green Spring's predicted number of species was 276, Plunkett and Mort's was 651 species, and Weldy's predicted value was 878 species. Green Spring was also depauperate with respect to species ranked S1, S2, or S3 by the Natural Heritage Program. Green Spring had no rare plants, the Tar Bay and Powell Creek watersheds had 7 (Mort 1994), Western Isle of Wight County had 14 rare plant species (Plunkett 1990), and the Corrotoman River watershed had 12 rare plant species (Weldy 1995).

Fig. 7. A plot of the number of species vs. area encompassed in the floristic studies at Green Spring, the Tar Bay and Powell Creek watersheds (32,000 acres; Mort 1994), Western Isle of Wight County (32,000 acres; Plunkett 1990), and the Corrotoman River watershed (51,200 acres; Weldy 1995). Labels above the data points denote the number of species.



DISCUSSION

Some of the most interesting floristic findings at Green Spring are species suspected to be descendants from the plants used in the horticultural and agricultural activities of William Berkeley and other 17th and 18th century landowners. *Narcissus pseudonarcissus* ‘Telamonius plenus’, a daffodil common in the mown field surrounding the Green Spring ruins, is a cultivar that was first registered in Great Britain in 1620 and was commonly brought to the colonies to adorn the colonists’ gardens in the New World (Brent Heath, Gloucester Daffodil Mart, personal communication). *Narcissus biflorus*, another species common in the mown field, was probably introduced by an early Green Spring landowner as well. Also, *Morus alba* (white mulberry) was brought to Green Spring to serve as a food source for silk-making larvae when the landowners were attempting to produce silk at Green Spring. This species has been identified in the lowland pine/mixed hardwood forest near the remains of Governor Berkeley’s manor house. Berkeley also produced timber from *Juglans nigra* (black walnut), which is a species native to this area. The fact that this species does occur naturally in this area could obscure any historical evidence, but this species was only common at Green Spring in the field surrounding the ruins and the adjacent woods. The mown field also contains several *Pyrus communis* (pear) individuals, which may be descendants of those grown by Berkeley, Philip Ludwell III, or William Lee. Some other species at Green Spring have been documented as important cultivated species at some point in the history of the land. These include *Asparagus officinalis* (asparagus) and *Phleum pratense* (timothy), both of

which occur in the mown field near the mansion's ruins.

Another interesting discovery at Green Spring was a series of parallel depressions in the ground in the forest west of the mown field. These depressions resemble agricultural furrows and could be remnants of farming activities at some point in the history of Green Spring. A study by Monette and Ware (1983) found that the oldest trees in a forest stand with importance values for *Pinus taeda*, *Quercus alba*, and *Fagus grandifolia* similar to those in Green Spring's pine/mixed hardwood forest were 65-70 years old. It is likely that these alleged furrows date at least to the early twentieth century since it takes some time for trees to invade in old field succession, and the time of invasion can vary from site to site (Monette and Ware 1983). It is possible, however, that these putative furrows are even older if this area has endured repeated episodes of disturbance.

Green Spring's flora consisted of 49 non-native species, which composed 20% of the flora. The overall proportion of exotics in Virginia is 22% (Terwilliger 1991), and floristic studies in the Coastal Plain have found between 17% and 25% of the species to be non-native (Weldy 1995). Though Green Spring does not have an abnormally high proportion of exotic species relative to Virginia as a whole and when compared to other areas in the Coastal Plain, several of these exotics are known to be aggressive in Virginia and pose threats to native species. For example, *Lespedeza cuneata* (Chinese lespedeza) is extremely common in the field at Green Spring and occurs in large monocultures. Like many members of the Fabaceae, this drought resistant plant fixes nitrogen, which can leave the area open for further invasion by non-native species normally limited by poor

soil conditions (DCR 1997). *Cirsium vulgare* (bull thistle) is another species common in the mown field and pipeline clearings that depletes resources for native plants (NHP 1997). *Lonicera japonica* (Japanese honeysuckle) is also quite abundant at Green Spring, particularly in the more disturbed parts of the forest. This climbing vine tends to strangle other plants, pull down trees, shade out desirable native species, and deplete soil moisture and nutrients (Williams 1998). *Microstegium vimineum* is another problematic exotic species which is quite abundant in the disturbed forests and clearings at Green Spring. *Rosa multiflora*, *Ailanthus altissima*, *Ligustrum sinense*, and *Glechoma hederacea* are currently uncommon at Green Spring, but they have the potential to outcompete native plants if they spread.

Green Spring was found to house 241 species of vascular plants, a number much smaller than what was found in other floristic studies in the Coastal Plain of Virginia that encompassed larger areas. Mort (1994) found 786 species, Plunkett (1990) found 603 species, and Weldy (1995) found 824 species. This can be linked to one of the fundamental concepts of insular ecology, the study of the relationship of species abundance to area: as the area studied increases in size, the number of species in that area should also increase. This theory is based on the idea that greater habitat availability and habitat diversity in larger sample areas allow greater numbers of species to inhabit the fragment (Wilcox 1980). Also, small sample areas may have fewer species because they will on average have smaller populations, and small populations are more vulnerable to chance events leading to extinction (Hunter 1996). Fig. 7, a plot of the area and species number of four studies, demonstrates how this principle plays out in study sites in the

Coastal Plain of Virginia. This plot is typical of most species/area curves in that a linear relationship exists between the log of the study area and the log of the number of species.

No rare, threatened, or endangered species were found at Green Spring, nor were any species designated S1, S2, or S3 by the Natural Heritage Program. This is a clear contrast with other floristic studies in the Coastal Plain of Virginia that encompassed a larger area. Mort (1994) found 7 rare species, Plunkett (1990) found 14, and Weldy (1995) found 12. According to the theories of insular ecology, one is likely to find both common and uncommon species when investigating a large area. However, when one is only sampling a small portion of an area, one is most likely to find only common species by chance alone. This may explain why Green Spring, a very small portion of land, contains fewer rare species than larger areas like the Tar Bay and Powell Creek watersheds, Western Isle of Wight County, or the Corrotoman River watershed. Additional factors contributing to the low number of species at Green Spring could be low substrate diversity and limited topographic gradient.

Detrended correspondence analysis (DCA) was used in combination with a visual assessment of the forest composition of each sample point to separate the plots at Green Spring forests into communities. DCA was also used to compare these communities to stands in other parts of Virginia's Coastal Plain. In each case, the successional pine forest and pine/mixed hardwood forest data points formed a coherent cluster, but the mixed hardwood data points were more scattered. At Green Spring, this dispersion can be related to the location of the plots: plots L, M, O, Q, and S are all in a dryer, more upland part of the site while plots C, D, F, G, K, and Y are located in a moist lowland portion of

the site (Fig. 4). For this reason, these plots were separated into upland mixed hardwood forest and lowland mixed hardwood forest communities. On the DCA ordination, plots F and C lie near the pine/mixed hardwood stands, but since plot F lacks pine and plot C had only one very large pine tree, they were grouped with the lowland mixed hardwood forest. In the DCA ordination comparing Green Spring's forest stands to other vegetational analyses, it is clear that the composition of Green Spring's forest is typical for Virginia's Coastal Plain, since these data points (Fig. 6, points 36-39) are not outliers.

The forest at Green Spring in the earliest stage of succession was heavily dominated by *Pinus taeda* (loblolly pine), as is typical for old field succession in the Coastal Plain of Virginia (Rice and Ware 1983). *Pinus taeda*'s importance value (I.V.) of 84.34 was much greater than the next most important species in this stand, *Liquidambar styraciflua*, which had I.V. = 6.76. This is normal for forests on Virginia's peninsula where early successional forests consist primarily of dense stands of loblolly pine with *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree), and *Acer rubrum* (red maple) entering the understory (Monette and Ware 1983). All of these invading species are present in Green Spring's successional pine forest, though the *Acer rubrum* individuals sampled were restricted to the small size class and therefore did not have an importance value calculated.

The next stage of forest succession in Virginia's Coastal Plain involves increasing invasion of hardwood trees and diminishing importance values for *Pinus taeda* (Monette and Ware 1983). This is evident in the pine/mixed hardwood stand at Green Spring where *Pinus taeda*'s importance value has decreased drastically to 37.83 from 84.34 in

the successional pine forest. Though loblolly pine is still the most important species in the canopy, *Liquidambar styraciflua* and *Liriodendron tulipifera* make a large contribution to this forest with I.V. = 25.97 and 11.92, respectively. *Pinus taeda* saplings are unable to thrive in the shade of a full-grown forest, so this species' contribution to the forest diminishes except in edges and clearings after the initial colonizers die. As the loblolly pines age in typical lowland Coastal Plain forests, *Liquidambar styraciflua* becomes a highly important species in the canopy. In upland forests, however, hardwood species such as *Quercus alba* (white oak) invade and become important canopy species, but early invaders like *Liquidambar styraciflua* and *Liriodendron tulipifera* are rarely able to achieve major importance. The successive invasion of hardwood trees like *Quercus alba*, *Quercus falcata* (Southern red oak), *Carya* spp. (hickories), and *Fagus grandifolia* (beech) are characteristic of this transition from early succession to a more mature forest. Also, *Cornus florida* (dogwood) and *Ilex opaca* (holly) become important constituents of the understory during this transitional stage (Monette and Ware 1983). All of these species are present in Green Spring's pine/mixed hardwood forest (Table 3).

In the moist lowland forests of Virginia's Coastal Plain, species like *Liquidambar styraciflua*, *Acer rubrum*, and *Fraxinus pennsylvanica* become highly important in the canopy as succession proceeds due to their greater tolerance for soil moisture (Glascok and Ware 1979). Green Spring's lowland forests have high importance values for these species (*L. styraciflua*'s I.V. = 27.61, *F. pennsylvanica*'s I.V. = 15.57, and *A. rubrum*'s I.V. = 25.57).

As successional processes continue in upland forests of the Coastal Plain of

Virginia, the importance values of species such as *Fagus grandifolia* and *Quercus alba* continue to increase, and these species eventually dominate the canopy of mature forests (Monette and Ware 1983). The beginning of this process can be seen in Green Spring's upland mixed hardwood stand (Table 5), where *Fagus grandifolia* has an I.V. = 11.02 and *Quercus alba* has an I.V. = 12.71. These values are still low and *Liquidambar styraciflua* currently dominates the forest, but this forest may not have reached the advanced stages of succession yet. It is important to note that *Fagus grandifolia* has a relatively high density in the small size class (17.37%), which means that this species has the potential to become more important in the future if young tree mortality is not abnormally high. In this category it is second in relative density only to *Ilex opaca*, which is a small tree that does not become an important canopy species. From this observation, it can be concluded that this stand may still be relatively young and undergoing successional processes.

There has been some controversy about the exact nature of Virginia's mature Coastal Plain forests throughout the past few decades. Several researchers have considered the climax vegetation to be an oak-hickory forest, but DeWitt and Ware (1979) found that the seven most important species in decreasing order in the upland hardwood forests of Virginia's central Coastal Plain are *Quercus alba*, *Fagus grandifolia*, *Liriodendron tulipifera*, *Quercus falcata*, *Carya tomentosa*, *Liquidambar styraciflua*, and *Carya glabra*, all of which are present in Green Spring's upland mixed hardwood forest (Table 5). With the exception of *Liriodendron tulipifera*, all of the species identified by Ware are important components of the Southern Mixed Hardwood Forest (SMHF) as

defined by Quarterman and Keever (1962). However, Virginia's Coastal Plain forests usually lack three species typical of the SMHF whose ranges rarely extend this far north: *Magnolia grandiflora*, *Quercus laurifolia*, and *Quercus nigra* (DeWitt and Ware 1979). These species are also absent or very rare in the forests at Green Spring. *Magnolia grandiflora* is not typically expected to reproduce or colonize naturally this far north (Donna Ware, College of William and Mary, personal communication), but there is one large individual at Green Spring that does not appear to have been planted by humans. In 1997 it was observed to flower and set seed, and there are some young individuals underneath the tree that appear to have sprouted from seed.

Currently, the ranking of species important in the upland hardwood forests of the Coastal Plain as reported by DeWitt and Ware (1979) does not match that found at Green Spring (Table 5), and many of the species typically associated with high importance values in the Coastal Plain SMHF stands are relatively low in importance at Green Spring. For example, *Carya tomentosa* and *Carya glabra* are each present in Green Spring's mixed hardwood forest, but have very low importance values (I.V. = 5.42 and 1.89, respectively). Monette and Ware (1983) noted that the highest densities of *Carya* spp. seedlings were found in beech dominated forests, but *Fagus grandifolia* is still fairly low in importance at Green Spring, probably due to the immaturity of the stand. Perhaps as the community continues the succession process more hickory seedlings will be present and hickory's importance in the upland forest at Green Spring will increase.

Another species commonly of moderately high importance in the SMHF is *Quercus falcata*, which is ranked fourth in importance in the upland mixed hardwood

forest and fifth in the lowland mixed hardwood and the pine/mixed hardwood forests at Green Spring. Monette and Ware (1983) suggested that it is mainly a canopy relict due to its lack of reproductive success within that stand. This hypothesis is consistent with Green Spring data where no *Quercus falcata* individuals were sampled in the small size class, indicating a lack of reproduction.

In general, Green Spring's woody vegetation seems to follow patterns common throughout the central Coastal Plain of Virginia. Though the forests are still undergoing successional processes, vegetational analyses and detrended correspondence analysis demonstrated that the woody species assemblages of the upland mixed hardwood forest show a strong alignment with the Southern Mixed Hardwood Forest typical of the area.

CONCLUSIONS

The floristic analysis at the Green Spring National Historic Park showed that 20% of the vascular plants are non-native, a value typical for Virginia where 22% of the plants are introduced species. No rare, threatened, or endangered species were found at Green Spring, perhaps due to the small sampling area. Other floristic analyses in Virginia's Coastal Plain did find rare species and a greater total number of species, which can be attributed to the fact that smaller sample areas generally contain fewer species and also fewer rare species.

Data from a vegetational analysis at Green Spring delineated four communities of woody species when analyzed with detrended correspondence analysis. These were successional pine forest, pine/mixed hardwood forest, lowland mixed hardwood forest, and upland mixed hardwood forest. Comparison of these stands with vegetational data from other analyses in Virginia's Coastal Plain demonstrated that Green Spring's woody species assemblages are quite similar to other forest stands.

The species diversity of Green Spring's forest communities was compared to other forests in the Coastal Plain by computing the Shannon index of diversity. Green Spring's successional pine forest and sweetgum-rich hardwood communities were less diverse than other stands sampled from larger areas, but its pine/mixed hardwood forest had an intermediate level of species diversity.

ANNOTATED CHECKLIST

This checklist includes information on the species' abundance at Green Spring, its habitat, and Ingram's collection number for the voucher specimen. Nomenclature follows Gleason and Cronquist (1991).

*=non-native

†=county record

FERNS AND FERN ALLIES

Aspleniaceae

Asplenium platyneuron (L.) Oakes. Common; moist hardwood forests; 39.

Dryopteris celsa (W. Palmer) Small. Occasional; moist clearing in forest; 38.

Polystichum acrostichoides (Michx.) Schott. Very common; hardwood forest; 37.

Lycopodiaceae

Lycopodium digitatum Dillen. Common; pine/mixed hardwood forest; 41.

Lycopodium obscurum L. Common; pine/mixed hardwood forest; 40.

Onocleaceae

Onoclea sensibilis L. Common; clearings and forest edge; 278.

Ophioglossaceae

† *Botrychium biternatum* (Savigny) Underw. Uncommon; pine woods; 299.

Botrychium dissectum Spreng. Occasional; forest edge; 307.

Osmundaceae

Osmunda regalis L. Occasional; pipeline clearing; 220.

GYMNOSPERMS

Cupressaceae

Juniperus virginiana L. Common; pine forests, forest edge; 234.

Pinaceae

Pinus taeda L. Very common; forests and edge; 243.

Pinus virginiana Miller. Common; mixed forests; 246.

ANGIOSPERMS

MONOCOTYLEDONS

Araceae

Arisaema triphyllum (L.) Schott var. *triphyllum*. Occasional; rich woods; 199.

Commelinaceae

* *Commelina communis* L. Occasional; moist roadsides; 230.

Cyperaceae

Carex amphibola Steudel. Occasional; pine woods; 75, 100.

Carex cephalophora Muhl. Occasional; near stream in upland forest; 164.

Carex complanata Torr. & Hook. Occasional; forest edge; 179.

Carex crinita Lam. var. *crinita*. Occasional; wooded stream banks; 137.

Carex debilis Michx. var. *debilis*. Common; forest edge; 98.

Carex digitalis Willd. Occasional; hardwood forest; 57.

Carex frankii Kunth. Common; forest edge; 195.

Carex intumescens Rudge. Occasional; pipeline clearing; 123.

Carex lurida Wahlenb. Occasional; pipeline clearing; 124.

Carex muhlenbergii Schk. Occasional; moist pine woods; 99.

Carex nigromarginata Schwein. Occasional; upland hardwood; 59.

† *Carex normalis* Mackenzie. Occasional; forest edge; 122.

Carex oxylepis Torr. & Hook. Common; hardwood forest; 120.

Carex rosea Schk. Locally abundant; forest edge; 121.

† *Carex virescens* Muhl. Occasional; moist pine woods; 97.

Carex vulpinoidea Michx. Occasional; pine forest; 97a.

Cyperus echinatus (L.) Wood. Occasional; field and clearings; 197.

Cyperus lancastricensis Porter. Occasional; pipeline clearing and field; 216.
Rhynchospora chalarocephala Fernald & Gale. Occasional; clearings; 253.
Scirpus cyperinus (L.) Kunth. Occasional; pipeline clearing; 250.

Iridaceae

Sisyrinchium angustifolium Miller. Uncommon; moist woods and clearings; 168.

Juncaceae

Juncus biflorus Elliott. Occasional; pipeline clearing; 212.
Juncus coriaceous Mackenzie. Occasional; hardwood forest; 153, 209.
Juncus effusus L. Very common; clearings, hardwood forests; 152.
Luzula bulbosa (A. Wood) Rydb. Occasional; hardwood forest; 58.

Lemnaceae

Lemna minor L. Common; woodland streams; 111.

Liliaceae

- * *Allium vineale* L. Common; mown field and clearings; 167, 193.
- * *Asparagus officinalis* L. Uncommon; mown field; 171.
- * *Hemerocallis fulva* (L.) L. Occasional; mown field; 192.
- * *Muscari botryoides* (L.) Miller. Uncommon; mown field; 80.
- * *Narcissus biflorus* Curt. Locally abundant; mown field; 82.
- * *Narcissus pseudonarcissus* L. Locally abundant; mown field; 70.
- * *Ornithogalum umbellatum* L. Occasional; mown field; 84.
- Smilacina racemosa* (L.) Desf. Occasional; upland hardwood forest; 105.

Orchidaceae

Cypripedium acaule Aiton. Rare; pine forest; no voucher.
Goodyera pubescens (Willd.) R. Brown. Common; hardwood forest; 206.
Liparis liliifolia (L.) Rich. Uncommon; rich woods; 141.
Malaxis unifolia Michx. Occasional; hardwood forest; 163.
Tipularia discolor (Pursh) Nutt. Common; pine forest; 229.

Poaceae

- * *Agrostis stolonifera* L. Occasional; mown field; 189.
- * *Anthoxanthum odoratum* L. Common; mown field; 116.
- Brachyelytrum erectum* (Schreber) P. Beauv. var. *septentrionale* Babel.
Common; hardwood forest; 201.
- Chasmanthium latifolium* (Michx.) Yates. Occasional; hardwood forest; 304.
- Chasmanthium laxum* (L.) Yates. Occasional; hardwood forest; 221.
- Cinna arundinacea* L. Common; roadside; 248.
- * *Dactylis glomerata* L. Occasional; mown field; 159.
- Danthonia spicata* (L.) F. Beauv. Occasional; pine forest; 178.
- Elymus virginicus* L. Common; pipeline clearing; 198.
- Erianthus giganteus* (Walter) Muhl. Occasional; moist meadow; 296.
- * *Festuca elatior* (L.) Vill. Occasional; forest edge; 169.
- * *Microstegium vimineum* (Trin.) A. Camus. Very common; disturbed forest; 326.
- Panicum philadelphicum* Bernh. Occasional; mown field; 185.
- * *Paspalum dilatatum* Poir. Common; mown field; 264.
- Paspalum laeve* Michx. Common; mown field; 252.
- * *Phleum pratense* L. Occasional; mown field; 186.
- * *Poa compressa* L. Occasional; pipeline clearing; 130.
- Setaria geniculata* (Lam.) P. Beauv. Common; mown field; 223.
- Sphenopholis pensylvanica* (L.) A. Hitchc. Common; hardwood forest; 113.
- Tridens flavus* (L.) A. Hitch. Common; mown field; 222.
- Tripsacum dactyloides* (L.) L. Common; mown field; 183.

Smilacaceae

Smilax rotundifolia L. Very common; disturbed forest; 237.

Typhaceae

Typha latifolia L. Uncommon; moist pipeline clearings; 213.

DICOTYLEDONS

Acanthaceae

Ruellia caroliniensis (Walter) Steudel. Occasional; mown field; 188.

Aceraceae

Acer rubrum L. Very common; forests; 46.

Anacardiaceae

Rhus copallinum L. Uncommon; edge of mown field; 272.
Toxicodendron radicans (L.) Kuntze. var. *radicans*. Very common; clearings, forests, and roadsides; 244.

Annonaceae

Asimina triloba (L.) Dunal. Common; forest and edge; 91.

Apiaceae

Chaerophyllum tainturieri Hook. Common; mown field; 85.
* *Daucus carota* L. Common; mown field and roadsides; 273.

Apocynaceae

Apocynum cannabinum L. Very common; mown field; 184.
* *Vinca minor* L. Occasional; edge of mown field; 87.

Aquifoliaceae

Ilex decidua Walter. Uncommon; pine-mixed hardwood forest; 129.
Ilex opaca Aiton. Very common; deciduous forest; 117.

Araliaceae

Aralia spinosa L. Occasional; forest edge; 245.

Asclepiadaceae

Asclepias variegata L. Uncommon; hardwood forest; 177.
Matelea gonocarpa (Walter) Shinnars. Occasional; mown field; 204.

Asteraceae

Achillea millefolium L. Common; mown field; 156.
Antennaria plantaginifolia (L.) Richardson var. *parlinii* (Fern.) Cronq. Uncommon; hardwood forest; 140.
Aster pilosus Willd. Common; pipeline clearing; 317.
Aster puniceus L. Common; pipeline clearing; 320.
* *Chrysanthemum leucanthemum* L. Common; mown field; 131.
* *Cirsium vulgare* (Savi) Tenore. Common; mown field; 263.
Elephantopus carolinianus Willd. Common; mown field; 266.

Erigeron strigosus Muhl. var. *strigosus*. Occasional; mown field; 158.
Eupatorium coelestinum L. Occasional; pipeline clearing; 255.
Eupatorium hyssopifolium L. Very common; mown field; 265.
Helenium autumnale L. Common; pipeline clearing; 215.
Mikania scandens (L.) Willd. Occasional; pine-mixed hardwood forest; 279.
Senecio aureus L. Very common; field and moist forest; 50, 155.
Silphium trifoliatum L. Occasional; pipeline clearing; 203.
Solidago caesia L. Occasional; hardwood forest; 303.
Solidago canadensis L. Common; mown field; 321.
Verbesina occidentalis (L.) Walter. Very common; mown field; 292.
Vernonia noveboracensis (L.) Michx. Common; pipeline clearing; 251.

Berberidaceae

Podophyllum peltatum L. Locally abundant; rich woods; 77.

Betulaceae

Alnus serrulata (Aiton.) Willd. Uncommon; lowland forest; 43.
Betula nigra L. Occasional; pine-mixed hardwood forest; 262.
Carpinus caroliniana Walter. Very common; hardwood forest; 54.

Bignoniaceae

Bignonia capreolata L. Occasional; pine-mixed hardwood forest; 103.
Campsis radicans (L.) Seemann. Very common; forest edge, roadsides; 191.

Boraginaceae

Myosotis macrosperma Engelm. Occasional; stream banks in forest; 90.

Brassicaceae

* *Barbarea verna* (Miller) Aschers. Occasional; mown field; 89.
Cardamine hirsuta L. Common; mown field and waste places; 47.
Lepidium virginicum var. *virginicum* L. Occasional; roadsides; 100.

Caesalpiniaceae

Cercis canadensis L. var. *canadensis*. Common; hardwood forest; 62, 239.

Campanulaceae

Lobelia siphilitica L. var. *siphilitica*. Occasional; pipeline clearing; 305.
Triodanis perfoliata (L.) Nieuwl. Occasional; forest clearings; 172.

Caprifoliaceae

- * *Lonicera japonica* Thunb. Very common; climbing on trees in forest edge; 145.
Sambucus canadensis L. Occasional; roadsides; 157.
Viburnum prunifolium L. Uncommon; on fence row bordering field; 81.

Caryophyllaceae

- Dianthus armeria* L. Occasional; mown field; 160.
- * *Stellaria media* (L.) Villars. Common; edges, roadsides; 66.

Celastraceae

Euonymus americanus L. Common; moist woods and roadsides; 128.

Clusiaceae

Hypericum perforatum L. Occasional; mown field; 187.
Hypericum stragulum P. Adams & Robson. Occasional; hardwood forest; 227.

Convolvulaceae

- * *Ipomoea purpurea* (L.) Roth. Occasional; roadside; 260.

Cornaceae

Cornus florida L. Very common; forest understory; 55.
Nyssa sylvatica Marshall. Common; pine-mixed hardwood forest; 294.

Ebenaceae

Diospyros virginiana L. Common; pine-mixed hardwood forest; 174.

Ericaceae

Chimaphila maculata (L.) Pursh. Occasional; pine-mixed hardwood forest; 182.
Gaylussacia frondosa (L.) T. & G. Common; pine-mixed hardwood forest; 102.
Vaccinium corymbosum L. Occasional; hardwood forest; 56.
Vaccinium stramineum L. Occasional; pine forest; 96.

Fabaceae

- Chamaecrista fasciculata* (Michaux) Greene. Uncommon; pipeline clearing; 261.
Desmodium paniculatum L. Common; mown field and pipeline clearing; 283.
* *Lespedeza cuneata* (Dum. Cours.) G. Don. Very common; mown field; 274.
* *Melilotus alba* Medikus. Occasional; pipeline clearing; 175.
Robinia pseudoacacia L. Occasional; forest edge; 107.
* *Trifolium campestre* Schreber. Occasional; mown field; 132.
* *Trifolium hybridum* L. Occasional; forest edge; 180.
* *Vicia angustifolia* L. Occasional; mown field; 83.

Fagaceae

- Fagus grandifolia* Ehrh. Common; rich hardwood forest; 143.
Quercus alba L. Common; mixed hardwood forest; 127.
Quercus coccinea Muenchh. Uncommon; mixed hardwood forest; no voucher.
Quercus falcata (Michx.) Common; mixed hardwood forest; 289.
Quercus michauxii Nutt. Uncommon; mixed hardwood forest; 240.
Quercus nigra L. Uncommon; mixed hardwood forest; 314.
Quercus phellos L. Common; mixed hardwood forest; 126.
Quercus rubra L. Common; mixed hardwood forest; 290.
Quercus velutina Lam. Common; mixed hardwood forest; 238.

Gentianaceae

- Gentiana villosa* L. Uncommon; pine forest; 298.
Sabatia angularis (L.) Pursh. Locally abundant; pipeline clearing; 214.

Geraniaceae

- * *Geranium dissectum* L. Occasional; mown field; 79.

Hamamelidaceae

- Liquidambar styraciflua* L. Very common; forest and unmown field; 94.

Juglandaceae

- Carya glabra* (Miller) Sweet. Occasional; upland hardwood forest; 297.
* *Carya illinoensis* (Wangenh) K. Koch. Common; mown field edge; 269.
† *Carya ovata* (Miller) K. Koch. Uncommon; field and mixed forest; 323, 324.
Carya tomentosa (Poiret) Nutt. Occasional; hardwood forest; 301.
Juglans nigra L. Occasional; field and pine-mixed hardwood forest; 106.

Lamiaceae

- * *Glechoma hederacea* L. Occasional; mown field; 65.
- * *Lamium purpureum* L. Occasional; mown field; 67.
- * *Leonurus cardiaca* L. Common; mown field; 165.
- Prunella vulgaris* L. var. *lanceolata* (Barton) Fern. Occasional; mown field; 267.
- Pycnanthemum tenuifolium* Schrader. Common; pipeline clearings; 202.
- * *Satureja calamintha* (L.) Scheele. Occasional; mown field; 225.
- Salvia lyrata* L. Occasional; edge of hardwood forest; 104.
- Scutellaria integrifolia* L. Uncommon; lowland forest; 194.

Lauraceae

- Lindera benzoin* (L.) Blume. Very common; pine-mixed hardwood forest; 45, 49.
- Sassafras albidum* (Nutt.) Nees. Occasional; upland hardwood forest; 288.

Loganiaceae

- Gelsemium sempervirens* (L.) Aiton. Common; pine forest; 60.

Magnoliaceae

- Liriodendron tulipifera* L. Very common; pine-mixed hardwood forest; 139.
- * *Magnolia grandiflora* L. Rare; pine-mixed hardwood forest; 256.

Melastomataceae

- Rhexia mariana* L. Occasional; pipeline clearing; 211.

Moraceae

- * *Morus alba* L. Uncommon; pine-mixed hardwood forest; 118.
- Morus rubra* L. Uncommon; pine-mixed hardwood forest; 315.

Myricaceae

- Myrica cerifera* L. Very common; pine forest; 74.

Oleaceae

- Fraxinus pennsylvanica* Marshall. Common; pine-mixed hardwood forest; 112.
* *Ligustrum sinense* Lour. Uncommon; edge of mown field; 176.

Onagraceae

- Circaea lutetiana* L. Common; upland hardwood forest; 173.
Ludwigia alternifolia L. Occasional; pipeline clearing; 196.
Oenothera biennis L. Uncommon; roadsides; 232.

Orobanchaceae

- Epifagus virginiana* (L.) Barton. Common; hardwood forest; 313.

Oxalidaceae

- Oxalis stricta* L. Common; mown field and roadsides; 133.

Passifloraceae

- Passiflora incarnata* L. Occasional; mown field; 208.

Phytolaccaceae

- Phytolacca americana* L. Common; roadsides and waste places; 270.

Plantaginaceae

- * *Plantago lanceolata* L. Occasional; mown field and roadsides; 115.

Platanaceae

- Platanus occidentalis* L. Common; pine-mixed hardwood forest; 257.

Polygonaceae

- * *Polygonum cespitosum* Blume var. *longisetum* (DeBruyn) Stewart. Common; roadsides and clearings; 309.
Polygonum pennsylvanicum L. Occasional; mown field; 275.
Polygonum punctatum Elliott. Common; edge of unmown field; 228.
Polygonum sagittatum L. Common; pipeline clearing; 318.
Polygonum virginianum L. Common; forest edge and clearings; 258.
* *Rumex acetosella* L. Common; mown field; 114.
* *Rumex crispus* L. Common; mown field; 181.

Portulacaceae

Claytonia virginica L. Common; hardwood forest; 44.

Ranunculaceae

Ranunculus abortivus L. Occasional; moist lowland forest; 63.

Ranunculus recurvatus Poir. Occasional; moist lowland forest; 95.

* *Ranunculus bulbosus* L. Occasional; field and roadsides; 68.

Rosaceae

Amelanchier arborea (Michx. f.) Fern. Occasional; upland hardwood forest; 302.

Amelanchier canadensis (L.) Medikus. Occasional; upland hardwood forest; 280.

Agrimonia pubescens Wallr. Uncommon; mixed hardwood forest; 200.

Aronia arbutifolia (L.) Elliott. Occasional; lowland forest; 71.

* *Duchesnea indica* (Andrews) Focke. Common; fields and roadsides; 64.

Geum canadense Jacq. Occasional; moist forest clearings; 147.

Potentilla canadensis L. Occasional; forest edges; 73.

Prunus serotina Ehrhart. Common; pine-mixed hardwood forest; 92, 207.

* *Pyrus communis* L. Uncommon; in middle of mown field; 53.

* *Rosa multiflora* Thunb. Occasional; forest edges; 119.

* *Rosa wichuraiana* Crepin. Occasional; mown field; 190.

Rubus argutus Link. Very common; unmown field; 108.

Rubiaceae

Cephalanthus occidentalis L. Common; moist clearings near pine forest; 226.

Diodia virginiana L. Occasional; pipeline clearings and roadsides; 231.

Galium aparine L. var. *echinospermum* (Wallr.) Farw. Common; hardwood forest and clearings; 72.

Galium obtusum Bigelow var. *filifolium* (Wiegand) Fern. Common; mixed hardwood forest; 125.

Galium pilosum Aiton var. *pilosum*. Common; hardwood forest; 142.

Hedyotis caerulea (L.) Hook. Uncommon; hardwood forest; 61.

Mitchella repens L. Common; hardwood forest; 135.

Salicaceae

Salix nigra Marshall var. *nigra*. Uncommon; moist forest; 109.

Scrophulariaceae

Agalinis purpurea (L.) Pennell. Common; pipeline clearing; 293.
Mecardonia acuminata (Walter) Small. Uncommon; mown field; 284.
Mimulus ringens L. Occasional; pipeline clearing; 259.

* *Verbascum blattaria* L. Occasional; mown field; 154.

Simaroubaceae

* *Ailanthus altissima* (Miller) Swingle. Uncommon; edge of mown field; 268.

Solanaceae

Solanum carolinense L. Common; mown field; 170.

Ulmaceae

Celtis occidentalis L. Common; edge of pine-mixed hardwood forest; 247.
Ulmus americana L. Common; pine-mixed hardwood forest; 249, 276.

Urticaceae

Boehmeria cylindrica (L.) Swartz. Common; moist lowland woods; 210.

Valerianaceae

Valerianella radiata (L.) Dufr. Occasional; stream banks; 78.

Verbenaceae

Phyrma leptostachya L. Occasional; moist hardwood forest; 204.
Verbena urticifolia L. Common; pipeline clearing; 219.

Violaceae

Viola primulifolia L. Uncommon; bank of wooded stream; 138.
Viola rafinesquii Greene. Occasional; forest edges; 69.
Viola sororia Willd. Common; moist lowland woods; 51, 88.

Viscaceae

Phoradendron serotinum (Raf.) M. C. Johnston. Common; hemi-parasitic on
Juglans spp. or *Carya* spp.; no voucher.

Vitaceae

Parthenocissus quinquefolia (L.) Planchon. Common; forests; 236.

Vitis labrusca L. Common; edge of unmown field; 151.

Vitis vulpina L. Common; forest clearings and edges; 161, 162.

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Appendix A. Data from vegetational analysis of individual plots at Green Spring. Relative Dominance is a measure of the relative proportion of cross-sectional area at

breast height for each species. Relative Density measures the proportion of stems in two size classes belonging to each species. Importance value (I.V.) is the average of the Relative Dominance and the Relative Density of the large size class.

Successional Pine forest

Species	Relative Dominance	Relative Density		I.V.
		Large	Small	
Plot A				
<i>Pinus taeda</i>	83.27	72.34	---	77.81
<i>Liquidambar styraciflua</i>	7.99	14.89	68.57	11.44
<i>Liriodendron tulipifera</i>	8.06	10.64	5.71	9.35
<i>Myrica cerifera</i>	0.68	2.13	2.86	1.40
<i>Acer rubrum</i>	---	---	17.14	---
<i>Ilex opaca</i>	---	---	2.86	---
<i>Juniperus virginiana</i>	---	---	2.86	---
Plot H				
<i>Pinus taeda</i>	83.76	66.67	14.29	75.22
<i>Liquidambar styraciflua</i>	8.16	9.52	42.86	8.84
<i>Pinus virginiana</i>	3.52	9.52	4.76	6.52
<i>Myrica cerifera</i>	2.52	9.52	---	6.02
<i>Liriodendron tulipifera</i>	2.03	4.76	4.76	3.40
<i>Cornus florida</i>	---	---	4.76	---
<i>Diospyros virginiana</i>	---	---	9.52	---
<i>Fagus grandifolia</i>	---	---	4.76	---
<i>Ilex opaca</i>	---	---	4.76	---
<i>Juniperus virginiana</i>	---	---	4.76	---
<i>Sassafras albidum</i>	---	---	4.76	---
Plot I				
<i>Pinus taeda</i>	100.00	100.0	---	100.0
<i>Liquidambar styraciflua</i>	---	---	81.82	---
<i>Ilex opaca</i>	---	---	5.45	---
<i>Juniperus virginiana</i>	---	---	3.64	--
<i>Myrica cerifera</i>	---	---	3.64	---
<i>Diospyros virginiana</i>	---	---	1.82	---
<i>Liriodendron tulipifera</i>	---	---	1.82	---
<i>Pinus virginiana</i>	---	---	1.82	---

Pine-Mixed Hardwood

Relative Relative Density

Species	Dominance	Large	Small	I.V.
Plot B				
<i>Liquidambar styraciflua</i>	47.85	41.18	---	44.52
<i>Acer rubrum</i>	22.56	23.53	50.00	22.57
<i>Pinus taeda</i>	18.53	11.76	---	15.14
<i>Diospyros virginiana</i>	6.66	17.65	50.00	12.16
<i>Nyssa sylvatica</i>	5.36	5.88	---	5.62
Plot E				
<i>Pinus taeda</i>	63.70	35.71	---	49.71
<i>Liriodendron tulipifera</i>	26.87	21.43	---	24.15
<i>Acer rubrum</i>	3.40	14.29	23.08	8.54
<i>Liquidambar styraciflua</i>	2.26	14.29	---	8.28
<i>Quercus alba</i>	3.40	7.14	---	5.27
<i>Fagus grandifolia</i>	0.99	7.14	15.38	4.06
<i>Ilex opaca</i>	---	---	61.54	---
Plot J				
<i>Liquidambar styraciflua</i>	26.07	34.29	---	30.68
<i>Liriodendron tulipifera</i>	35.42	5.88	---	20.65
<i>Pinus taeda</i>	26.36	11.76	---	19.06
<i>Cornus florida</i>	6.20	17.65	38.46	11.93
<i>Ulmus americana</i>	3.10	17.65	---	10.37
<i>Juglans nigra</i>	1.87	5.88	---	3.88
<i>Acer rubrum</i>	0.98	5.88	7.69	3.43
<i>Ilex opaca</i>	---	---	53.85	---

Plot
N
Liriod

<i>Liriodendron tulipifera</i>	50.35	25.00	3.80	37.68
<i>Pinus taeda</i>	19.24	33.33	8.86	26.29
<i>Quercus falcata</i>	22.19	8.33	---	15.26
<i>Liquidambar styraciflua</i>	3.65	16.67	29.11	10.16
<i>Quercus velutina</i>	2.82	8.33	1.27	5.57
<i>Ilex opaca</i>	1.75	8.33	13.92	5.04
<i>Carpinus caroliniana</i>	---	---	11.39	---
<i>Carya tomentosa</i>	---	---	8.86	---
<i>Quercus alba</i>	---	---	8.86	---
<i>Cornus florida</i>	---	---	6.33	---
<i>Acer rubrum</i>	---	---	2.53	---
<i>Quercus rubra</i>	---	---	2.53	---
<i>Fagus grandifolia</i>	---	---	1.27	---
<i>Quercus coccinea</i>	---	---	1.27	---
Plot P				
<i>Pinus taeda</i>	47.77	47.06	---	47.41
<i>Carya tomentosa</i>	38.89	5.88	---	22.39
<i>Quercus rubra</i>	5.57	17.65	4.00	11.61
<i>Liquidambar styraciflua</i>	1.20	11.76	36.00	6.48
<i>Liriodendron tulipifera</i>	3.94	5.88	4.00	4.91
<i>Quercus phellos</i>	1.64	5.88	---	3.76
<i>Acer rubrum</i>	0.99	5.88	8.00	3.43
<i>Carpinus caroliniana</i>	---	---	12.00	---
<i>Diospyros virginiana</i>	---	---	8.00	---
<i>Ilex opaca</i>	---	---	8.00	---
<i>Nyssa sylvatica</i>	---	---	8.00	---
<i>Cornus florida</i>	---	---	4.00	---
<i>Quercus alba</i>	---	---	4.00	---
<i>Vaccinium corymbosum</i>	---	---	4.00	---
Plot R				
<i>Liriodendron tulipifera</i>	35.31	28.57	7.50	31.94
<i>Liquidambar styraciflua</i>	26.67	33.33	25.00	30.00
<i>Pinus taeda</i>	20.39	14.29	---	17.34
<i>Acer rubrum</i>	12.82	14.29	20.00	13.56
<i>Carya tomentosa</i>	4.10	4.76	5.00	4.43
<i>Quercus michauxii</i>	0.71	4.76	2.50	2.73
<i>Fagus grandifolia</i>	---	---	20.00	---
<i>Cornus florida</i>	---	---	25.00	---
<i>Carpinus caroliniana</i>	---	---	7.50	---
<i>Quercus rubra</i>	---	---	5.00	---
<i>Ilex opaca</i>	---	---	2.50	---
<i>Quercus phellos</i>	---	---	2.50	---

Plot T				
<i>Pinus taeda</i>	61.51	30.43	---	45.97
<i>Liquidambar styraciflua</i>	15.23	39.13	21.43	27.18
<i>Liriodendron tulipifera</i>	17.46	8.70	---	13.08
<i>Cornus florida</i>	4.13	17.39	42.86	10.76
<i>Acer rubrum</i>	1.67	4.35	7.14	3.01
<i>Ilex opaca</i>	---	---	21.43	---
<i>Quercus rubra</i>	---	---	7.14	---
Plot U				
<i>Pinus taeda</i>	85.05	48.15	---	66.60
<i>Liquidambar styraciflua</i>	8.49	33.33	56.25	20.91
<i>Platanus occidentalis</i>	1.79	11.11	---	6.45
<i>Acer rubrum</i>	2.63	3.70	25.00	3.17
<i>Liriodendron tulipifera</i>	2.05	3.70	---	2.87
<i>Ilex opaca</i>	---	---	12.50	---
<i>Fagus grandifolia</i>	---	---	6.25	---
Plot V				
<i>Liquidambar styraciflua</i>	30.58	60.87	---	45.73
<i>Pinus taeda</i>	62.63	26.09	---	44.36
<i>Acer rubrum</i>	3.75	8.70	60.00	6.22
<i>Fraxinus pennsylvanica</i>	3.03	4.35	4.35	3.69
<i>Ulmus americana</i>	---	---	20.00	---
<i>Ilex opaca</i>	---	---	13.33	---
<i>Liriodendron tulipifera</i>	---	---	6.67	---
Plot W				
<i>Liquidambar styraciflua</i>	48.16	72.00	10.53	60.08
<i>Pinus taeda</i>	49.76	20.00	---	34.88
<i>Acer rubrum</i>	1.12	4.00	10.53	2.56
<i>Ilex opaca</i>	0.97	4.00	36.84	2.48
<i>Liriodendron tulipifera</i>	---	---	31.58	---
<i>Cornus florida</i>	---	---	5.26	---
<i>Quercus rubra</i>	---	---	5.26	---
Plot X				
<i>Pinus taeda</i>	84.89	55.00	---	69.94
<i>Liquidambar styraciflua</i>	6.36	30.00	21.43	18.18
<i>Liriodendron tulipifera</i>	5.55	10.00	---	7.78
<i>Ulmus americana</i>	3.21	5.00	---	4.10
<i>Acer rubrum</i>	---	---	71.43	---
<i>Cornus florida</i>	---	---	7.14	---

Lowland Hardwood Forest

Species	Relative Dominance	Large	Small	I.V.
Plot C				
<i>Liquidambar styraciflua</i>	43.25	50.00	5.88	46.63
<i>Acer rubrum</i>	26.19	18.75	41.18	22.47
<i>Pinus taeda</i>	22.51	6.25	---	14.38
<i>Nyssa sylvatica</i>	4.37	12.50	5.88	8.44
<i>Quercus velutina</i>	2.77	6.25	---	4.51
<i>Ulmus americana</i>	0.90	6.25	---	3.57
<i>Cornus florida</i>	---	---	17.65	---
<i>Fagus grandifolia</i>	---	---	17.65	---
<i>Liriodendron tulipifera</i>	---	---	5.88	---
<i>Quercus michauxii</i>	---	---	5.88	---
Plot D				
<i>Fraxinus pennsylvanica</i>	52.81	38.10	---	45.45
<i>Acer rubrum</i>	25.72	38.10	13.33	31.91
<i>Liquidambar styraciflua</i>	20.04	19.05	---	19.54
<i>Ulmus americana</i>	1.43	4.76	60.00	3.09
<i>Ilex opaca</i>	---	---	20.00	---
<i>Cornus florida</i>	---	---	6.67	---
Plot F				
<i>Liquidambar styraciflua</i>	42.18	22.22	33.33	42.18
<i>Ulmus americana</i>	27.53	33.33	---	27.53
<i>Ilex opaca</i>	8.41	11.11	44.44	8.41
<i>Juglans nigra</i>	7.64	11.11	---	7.64
<i>Liriodendron tulipifera</i>	7.18	11.11	---	7.18
<i>Acer rubrum</i>	7.06	11.11	---	7.06
<i>Cornus florida</i>	---	---	22.22	---
Plot G				
<i>Fraxinus pennsylvanica</i>	20.91	36.84	---	28.88
<i>Carya ovata</i>	46.74	5.26	---	26.00
<i>Acer rubrum</i>	12.84	31.58	50.00	22.21
<i>Ulmus americana</i>	6.25	10.53	---	8.39
<i>Pinus taeda</i>	7.90	5.26	---	6.58
<i>Liquidambar styraciflua</i>	3.84	5.26	12.50	4.55
<i>Liriodendron tulipifera</i>	1.52	5.26	---	3.39
<i>Cornus florida</i>	---	---	12.50	---
<i>Diospyros virginiana</i>	---	---	12.50	---
<i>Ilex opaca</i>	---	---	12.50	---

Plot K				
<i>Acer rubrum</i>	44.21	43.75	20.00	43.98
<i>Fraxinus pennsylvanica</i>	25.67	12.50	---	19.09
<i>Liquidambar styraciflua</i>	17.24	12.50	10.00	14.87
<i>Ilex opaca</i>	2.39	12.50	60.00	7.44
<i>Liriodendron tulipifera</i>	8.26	6.25	---	7.26
<i>Ulmus americana</i>	1.39	6.25	10.00	3.82
<i>Morus rubra</i>	0.84	6.25	---	3.55
Plot Y				
<i>Liquidambar styraciflua</i>	34.07	41.67	---	37.87
<i>Quercus falcata</i>	46.02	8.33	---	27.17
<i>Acer rubrum</i>	18.27	33.33	23.08	25.80
<i>Ilex opaca</i>	1.64	16.67	46.15	9.16
<i>Ulmus americana</i>	---	---	30.77	---

Upland Hardwood Forest

Species	Relative Dominance	Relative Density		I.V.
		Large	Small	
Plot L				
<i>Quercus phellos</i>	34.27	16.67	---	25.47
<i>Quercus alba</i>	18.99	16.67	---	17.83
<i>Pinus taeda</i>	17.87	16.67	10.00	17.27
<i>Quercus falcata</i>	13.05	16.67	---	14.86
<i>Nyssa sylvatica</i>	3.38	16.67	2.50	10.02
<i>Liquidambar styraciflua</i>	10.49	8.33	30.00	9.41
<i>Cornus florida</i>	1.95	8.33	2.50	5.14
<i>Ilex opaca</i>	---	---	50.00	---
<i>Liriodendron tulipifera</i>	---	---	2.50	---
<i>Sassafras albidum</i>	---	---	2.50	---
Plot M				
<i>Liquidambar styraciflua</i>	29.08	18.18	33.33	23.63
<i>Ilex opaca</i>	9.15	31.82	33.33	20.48
<i>Quercus phellos</i>	21.10	4.55	---	12.82
<i>Carya glabra</i>	9.85	9.09	---	9.47
<i>Pinus taeda</i>	9.43	4.55	---	6.99
<i>Acer rubrum</i>	2.74	9.09	11.11	5.92
<i>Quercus alba</i>	6.93	4.55	---	5.74
<i>Liriodendron tulipifera</i>	5.47	4.55	---	5.01
<i>Quercus velutina</i>	4.18	4.55	---	4.36
<i>Quercus rubra</i>	1.27	4.55	---	2.91
<i>Carpinus caroliniana</i>	0.79	4.55	---	2.67
<i>Cornus florida</i>	---	---	5.56	---
<i>Fagus grandifolia</i>	---	---	5.56	---
<i>Fraxinus pennsylvanica</i>	---	---	5.56	---
<i>Juniperus virginiana</i>	---	---	5.56	---
Plot O				
<i>Quercus falcata</i>	45.72	10.00	---	27.86
<i>Liquidambar styraciflua</i>	16.60	30.00	---	23.30
<i>Acer rubrum</i>	15.41	20.00	---	17.71
<i>Fagus grandifolia</i>	12.17	20.00	27.27	16.09
<i>Quercus alba</i>	6.95	10.00	---	8.47
<i>Quercus rubra</i>	3.14	10.00	---	6.57
<i>Ilex opaca</i>	---	---	45.45	---
<i>Carpinus caroliniana</i>	---	---	18.18	---
<i>Carya glabra</i>	---	---	9.09	---

Plot Q				
<i>Liquidambar styraciflua</i>	31.76	29.41	---	30.59
<i>Carya tomentosa</i>	30.69	23.53	---	27.11
<i>Quercus alba</i>	28.45	5.88	---	17.16
<i>Fagus grandifolia</i>	2.36	11.76	14.29	7.06
<i>Carpinus caroliniana</i>	1.91	11.76	9.52	6.84
<i>Liriodendron tulipifera</i>	1.78	5.88	---	3.83
<i>Cornus florida</i>	1.57	5.88	33.33	3.73
<i>Ilex opaca</i>	1.48	5.88	42.86	3.68
Plot S				
<i>Fagus grandifolia</i>	21.81	42.11	45.16	31.96
<i>Quercus alba</i>	18.12	10.53	---	14.33
<i>Quercus rubra</i>	22.33	5.26	---	13.80
<i>Liriodendron tulipifera</i>	16.80	10.53	---	13.67
<i>Liquidambar styraciflua</i>	15.80	10.53	---	13.17
<i>Quercus velutina</i>	2.01	5.26	---	3.64
<i>Acer rubrum</i>	1.35	5.26	---	3.30
<i>Ilex opaca</i>	0.98	5.26	22.58	3.12
<i>Carpinus caroliniana</i>	0.79	5.26	19.35	3.02
<i>Cornus florida</i>	---	---	9.68	---
<i>Nyssa sylvatica</i>	---	---	3.23	---

Scientific name	Common name
<i>Acer rubrum</i>	red maple
<i>Achillea millefolium</i>	yarrow
<i>Agalinis purpurea</i>	smooth agalinis
<i>Agrimonia pubescens</i>	downy agrimony
<i>Agrostis stolonifera</i>	creeping bent-grass
<i>Ailanthus altissima</i>	tree of heaven
<i>Allium vineale</i>	field-garlic; scallions
<i>Alnus serrulata</i>	smooth alder
<i>Amelanchier arborea</i>	downy serviceberry
<i>Amelanchier canadensis</i>	shadbush; eastern serviceberry
<i>Antennaria plantaginifolia</i>	plantain pussytoes
<i>Anthoxanthum odoratum</i>	sweet vernal grass
<i>Apocynum cannabinum</i>	Indian hemp
<i>Aralia spinosa</i>	Hercules' club
<i>Arisaema triphyllum</i>	Jack-in-the-pulpit
<i>Aronia arbutifolia</i>	red chokeberry
<i>Asclepias variegata</i>	white milkweed
<i>Asimina triloba</i>	paw-paw
<i>Asparagus officinalis</i>	asparagus
<i>Asplenium platyneuron</i>	ebony spleenwort
<i>Aster pilosus</i>	awl-aster
<i>Aster puniceus</i>	bristly aster
<i>Barbarea verna</i>	early water-cress
<i>Betula nigra</i>	river birch; red birch
<i>Bignonia capreolata</i>	cross-vine
<i>Boehmeria cylindrica</i>	false nettle
<i>Botrychium biternatum</i>	sparse-lobed grape-fern
<i>Botrychium dissectum</i>	lace-frond grape-fern
<i>Brachyelytrum erectum</i>	----
<i>Campsis radicans</i>	trumpet-creeper
<i>Cardamine hirsuta</i>	hoary bitter-cress
<i>Carex amphibola</i>	sedge
<i>Carex cephalophora</i>	sedge
<i>Carex complanata</i>	sedge
<i>Carex crinita</i>	sedge
<i>Carex debilis</i>	sedge
<i>Carex digitalis</i>	sedge
<i>Carex frankii</i>	sedge
<i>Carex intumescens</i>	sedge

<i>Carex lurida</i>	sedge
<i>Carex muhlenbergii</i>	sedge
<i>Carex nigromarginata</i>	sedge
<i>Carex normalis</i>	sedge
<i>Carex oxylepsis</i>	sedge
<i>Carex rosea</i>	sedge
<i>Carex virescens</i>	sedge
<i>Carex vulpinoidea</i>	sedge
<i>Carpinus caroliniana</i>	musclewood; hornbeam; blue beech; ironwood
<i>Carya glabra</i>	pignut-hickory
<i>Carya illinoensis</i>	pecan
<i>Carya ovata</i>	shagbark hickory
<i>Carya tomentosa</i>	mockernut hickory
<i>Celtis occidentalis</i>	northern hackberry
<i>Cephalanthus occidentalis</i>	buttonbush
<i>Cercis canadensis</i>	redbud
<i>Chaerophyllum tainturieri</i>	southern chervil
<i>Chamaecrista fasciculata</i>	partridge-pea; locust-weed
<i>Chasmanthium latifolium</i>	wild oats
<i>Chasmanthium laxum</i>	----
<i>Chimaphila maculata</i>	spotted wintergreen
<i>Chrysanthemum leucanthemum</i>	ox-eye daisy
<i>Cinna arundinacea</i>	common woodreed
<i>Circaea lutetiana</i>	common enchanter's nightshade
<i>Cirsium vulgare</i>	bull-thistle
<i>Claytonia virginica</i>	spring-beauty
<i>Commelina communis</i>	common day-flower
<i>Cornus florida</i>	flowering dogwood
<i>Cyperus echinatus</i>	globe flat-sedge
<i>Cyperus lancastriensis</i>	flatsedge
<i>Cypripedium acaule</i>	pink lady's slipper; moccasin flower
<i>Dactylis glomerata</i>	orchard-grass
<i>Danthonia spicata</i>	poverty oatgrass
<i>Daucus carota</i>	Queen Anne's lace; wild carrot
<i>Desmodium paniculatum</i>	tick-trefoil
<i>Dianthus armeria</i>	Deptford pink
<i>Diodia virginiana</i>	Virginia-buttonweed
<i>Diospyros virginiana</i>	persimmon
<i>Dryopteris celsa</i>	log-fern
<i>Duchesnia indica</i>	Indian strawberry
<i>Elephantopus carolinianus</i>	leafy elephant's foot

<i>Elymus virginicus</i>	Virginia wild rye
<i>Epifagus virginiana</i>	beech-drops
<i>Erianthus giganteus</i>	sugar-cane plumegrass
<i>Erigeron strigosus</i>	rough fleabane
<i>Euonymus americanus</i>	strawberry bush; American burning bush
<i>Eupatorium coelestinum</i>	mist-flower
<i>Eupatorium hyssopifolium</i>	-----
<i>Fagus grandifolia</i>	American beech
<i>Festuca elatior</i>	tall fescue
<i>Fraxinus pennsylvanica</i>	green ash
<i>Galium aparine</i>	cleavers
<i>Galium obtusum</i>	bluntleaf bedstraw
<i>Galium pilosum</i>	bedstraw
<i>Gaylussacia frondosa</i>	dangleberry
<i>Gelsemium sempervirens</i>	yellow jessamine
<i>Gentiana villosa</i>	striped gentian
<i>Geranium dissectum</i>	wild geranium; crane's bill
<i>Geum canadense</i>	white avens
<i>Glechoma hederacea</i>	gill-over-the-ground
<i>Goodyera pubescens</i>	rattlesnake plantain
<i>Hedyotis caerulea</i>	bluets
<i>Helenium autumnale</i>	common sneezeweed
<i>Hemerocallis fulva</i>	day-lily
<i>Hypericum perforatum</i>	common St. John's wort
<i>Hypericum stragulum</i>	St. John's wort
<i>Ilex decidua</i>	possum-haw
<i>Ilex opaca</i>	American holly
<i>Ipomoea purpurea</i>	morning glory
<i>Juglans nigra</i>	black walnut
<i>Juncus biflorus</i>	rush
<i>Juncus coriaceous</i>	rush
<i>Juncus effusus</i>	soft rush
<i>Juniperus virginiana</i>	eastern red cedar
<i>Lamium purpureum</i>	red dead nettle
<i>Lemna minor</i>	duckweed
<i>Leonurus cardiaca</i>	motherwort; lion's tail
<i>Lepidium virginicum</i>	poor-man's pepper
<i>Lespedeza cuneata</i>	Chinese lespedeza
<i>Ligustrum sinense</i>	Chinese privet
<i>Lindera benzoin</i>	spicebush
<i>Liparis liliifolia</i>	large twayblade

<i>Liquidambar styraciflua</i>	sweet gum
<i>Liriodendron tulipifera</i>	tulip poplar
<i>Lobelia siphilitica</i>	lobelia
<i>Lonicera japonica</i>	Japanese honeysuckle
<i>Ludwigia alternifolia</i>	square pod; water primrose
<i>Luzula bulbosa</i>	wood-rush
<i>Lycopodium digitatum</i>	southern ground cedar
<i>Lycopodium obscurum</i>	princess-pine, ground-pine
<i>Magnolia grandifolia</i>	bull-bay; southern magnolia
<i>Malaxis unifolia</i>	green adder's mouth
<i>Matelea gonocarpa</i>	common angle-pod
<i>Mecardonia acuminata</i>	-----
<i>Melilotus alba</i>	white sweet clover
<i>Microstegium vimineum</i>	eulalia
<i>Mikania scandens</i>	climbing hempweed
<i>Mimulus ringens</i>	Allegheny monkey-flower
<i>Mitchella repens</i>	partridge-berry
<i>Morus alba</i>	white mulberry
<i>Morus rubra</i>	red mulberry
<i>Muscari botryoides</i>	grape hyacinth
<i>Myosotis macrosperma</i>	big-seed scorpion-grass
<i>Myrica cerifera</i>	wax-myrtle
<i>Narcissus biflorus</i>	daffodil
<i>Narcissus pseudonarcissus</i>	daffodil
<i>Nyssa sylvatica</i>	black tupelo; black gum
<i>Oenothera biennis</i>	common evening-primrose
<i>Onoclea sensibilis</i>	sensitive fern
<i>Ornithogalum umbellatum</i>	Bethlehem star
<i>Osmunda regalis</i>	royal fern
<i>Oxalis stricta</i>	common yellow wood-sorrel
<i>Panicum philadelphicum</i>	panic-grass
<i>Parthenocissus quinquefolia</i>	Virginia creeper
<i>Paspalum dilatatum</i>	Dallis-grass
<i>Paspalum laeve</i>	bead-grass
<i>Passiflora incarnata</i>	Maypops; passion-flower
<i>Phleum pratense</i>	timothy
<i>Phoradendron serotinum</i>	American Christmas-mistletoe
<i>Phryma leptostachya</i>	lopseed
<i>Phytolacca americana</i>	pokeweed
<i>Pinus taeda</i>	loblolly pine
<i>Pinus virginiana</i>	Virginia pine

<i>Plantago lanceolata</i>	English plantain
<i>Platanus occidentalis</i>	sycamore
<i>Poa compressa</i>	Canada bluegrass
<i>Podophyllum peltatum</i>	mayapple
<i>Polygonum cespitosum</i>	smartweed
<i>Polygonum pennsylvanicum</i>	Pennsylvania smartweed
<i>Polygonum punctatum</i>	dotted smartweed
<i>Polygonum sagittatum</i>	arrow-leaved tearthumb
<i>Polygonum virginianum</i>	jumpseed
<i>Polystichum acrostichoides</i>	Christmas fern
<i>Potentilla canadensis</i>	running five-fingers
<i>Prunella vulgaris</i>	self-heal
<i>Prunus serotina</i>	wild black cherry
<i>Pycnanthemum tenuifolium</i>	mountain mint
<i>Pyrus communis</i>	pear
<i>Quercus alba</i>	white oak
<i>Quercus coccinea</i>	scarlet oak
<i>Quercus falcata</i>	southern red oak
<i>Quercus michauxii</i>	swamp chestnut oak
<i>Quercus nigra</i>	water oak
<i>Quercus phellos</i>	willow oak
<i>Quercus rubra</i>	northern red oak
<i>Quercus velutina</i>	black oak
<i>Ranunculus abortivus</i>	small-flowered crowfoot
<i>Ranunculus bulbosus</i>	bulbous buttercup
<i>Ranunculus recurvatus</i>	hooked crowfoot
<i>Rhexia mariana</i>	dull meadow-pitcher
<i>Rhus copallinum</i>	winged sumac
<i>Rhynchospora chalarocephala</i>	beak-rush
<i>Robinia pseudoacacia</i>	black locust
<i>Rosa multiflora</i>	multiflora rose
<i>Rosa wichuraiana</i>	memorial rose
<i>Rubus argutus</i>	southern blackberry
<i>Ruellia caroliniensis</i>	-----
<i>Rumex acetosella</i>	red sorrel
<i>Rumex crispus</i>	curly dock
<i>Sabatia angularis</i>	common marsh pink
<i>Salix nigra</i>	black willow
<i>Salvia lyrata</i>	sage
<i>Sambucus canadensis</i>	common elder
<i>Sassafras albidum</i>	sassafras

<i>Satureja calamintha</i>	basil-thyme
<i>Scirpus cyperinus</i>	wool-grass
<i>Scutellaria integrifolia</i>	skullcap
<i>Senecio aureus</i>	heart-leaved groundsel; ragwort
<i>Setaria geniculata</i>	knotroot-foxtail grass
<i>Silphium trifoliatum</i>	whorled rosin-weed
<i>Sisyrinchium angustifolium</i>	blue-eyed grass
<i>Smilacina racemosa</i>	false Solomon's seal
<i>Smilax rotundifolia</i>	green briar
<i>Solanum carolinense</i>	horse-nettle
<i>Solidago caesia</i>	axillary goldenrod
<i>Solidago canadensis</i>	common goldenrod
<i>Sphenopholis pensylvanica</i>	-----
<i>Stellaria media</i>	chickweed
<i>Tipularia discolor</i>	crane-fly orchid
<i>Toxicodendron radicans</i>	poison ivy
<i>Tridens flavus</i>	purpletop
<i>Trifolium campestre</i>	pinnate hop-clover
<i>Trifolium hybridum</i>	alsike clover
<i>Triodanis perfoliata</i>	round-leaved triodanis
<i>Tripsacum dactyloides</i>	gama-grass
<i>Typha latifolia</i>	common cattail
<i>Ulmus americana</i>	white or American elm
<i>Vaccinium corymbosum</i>	highbush blueberry
<i>Vaccinium stramineum</i>	deerberry
<i>Valerianella radiata</i>	corn-salad
<i>Verbascum blattaria</i>	moth-mullein
<i>Verbena urticifolia</i>	white vervain
<i>Verbesina occidentalis</i>	southern flatseed sunflower
<i>Vernonia noveboracensis</i>	New York ironweed
<i>Viburnum prunifolium</i>	black haw
<i>Vicia angustifolia</i>	narrow-leaved vetch
<i>Vinca minor</i>	periwinkle
<i>Viola primulifolia</i>	primrose-leaved violet
<i>Viola rafinesquii</i>	wild pansy
<i>Viola sororia</i>	dooryard violet
<i>Vitis labrusca</i>	fox-grape
<i>Vitis vulpina</i>	frost-grape